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Vol 29. 505 PEARL STREET, NEW YORK. No. 40

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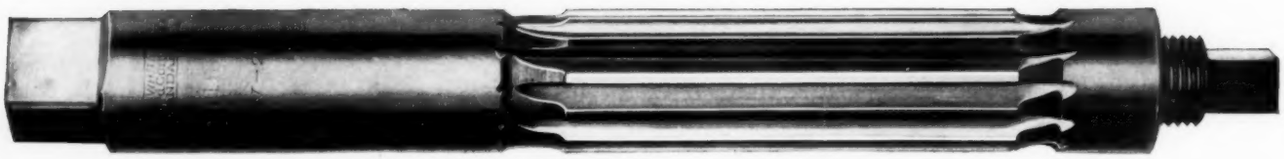

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GRADUATING RANGE DIALS FOR NAVY GUNS

An Unusual Problem and Its Simple Solution

BY J. J. STRONG

After reading several articles that have been published in these columns regarding the different methods of graduating range dials with unequal divisions, I have come to the conclusion that I can help those of your readers who have such work to do, by describing the method used in the miscellaneous shop of the Washington Navy Yard, in graduating the dials for three-inch sights, Mk. vii, by which we have graduated something over 300 dials. The device used is so simple and efficient that all the marks on this dial, which consist of 260 lines of three different lengths, can be made in six minutes. The dial can be placed in the machine and taken out again, completed, in ten minutes. The work can be done by an apprentice, although we use a first-class man because of the importance of this part of the sight. The three-inch Mk. vii sight is the original yoke sight adopted by the United States navy; modified forms of this sight have since been adopted for all caliber guns.

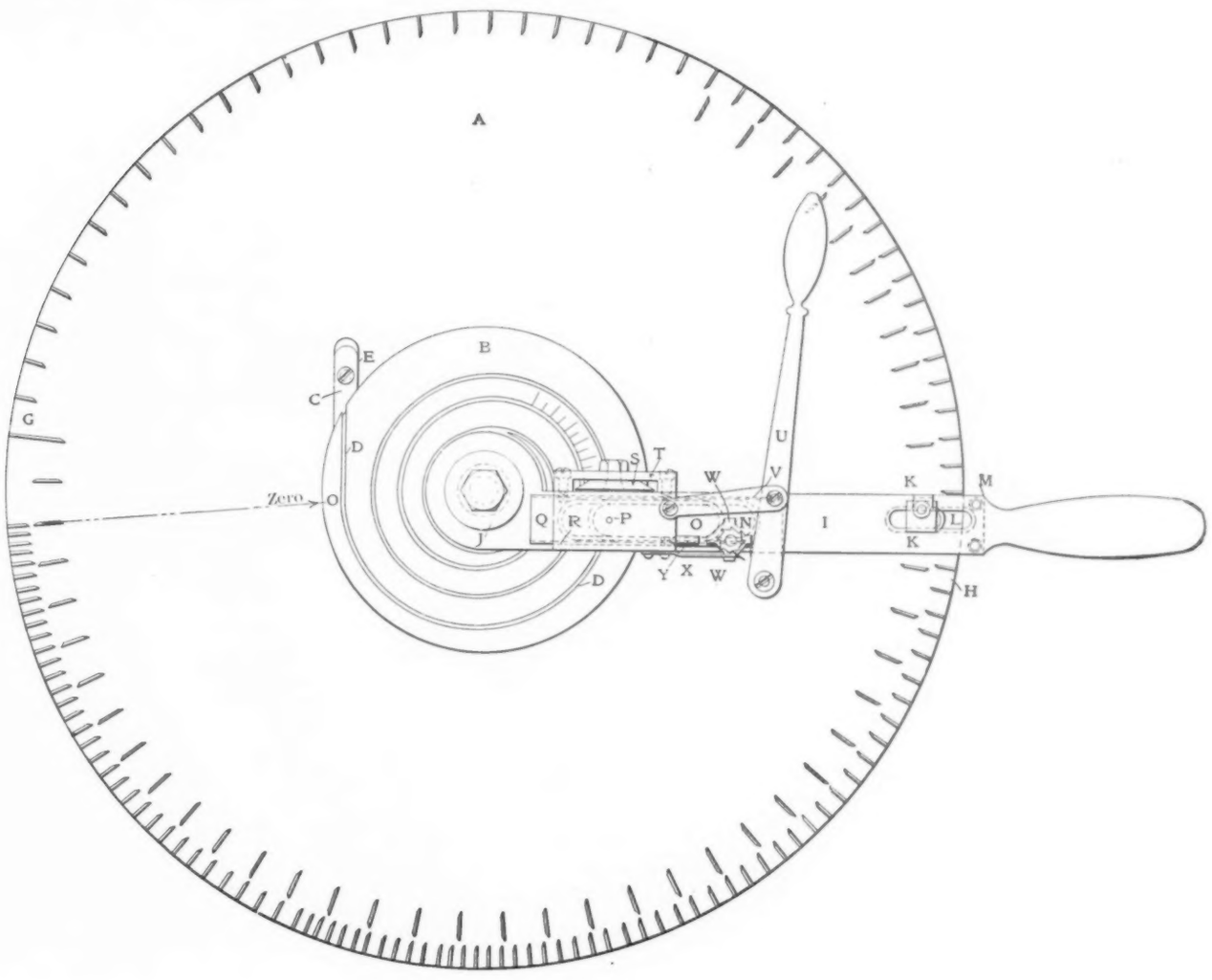

FIG. 1. GRADUATING MACHINE FOR UNEQUAL DIVISIONS.

THE MASTER DIAL.

The main part of the machine is a steel disk or master dial *A*, Fig. 1, 30 inches in diameter, and about one inch thick, finished all over, counterbored in the center for the range dial to stand 0.02 inch above the steel plate. *C* is a slide which engages the groove *D* in the range dials, and locates them in the correct position in the machine, the slide being locked with the countersunk screw *E*. Since the graduations occupy more than a complete circle the range dial is graduated on a spiral. By referring to Fig. 2 it will be seen that the dimensions on the dial are given in degrees, minutes and tenths of minutes. To get these measurements it was necessary to make a dial for a circular table, with which it would be possible, by the aid of a vernier, to read seconds. The steel plate *A* was clamped on this table, on the mill-

ing machine, and with a 60-degree cutter the ratchet teeth G were cut about three-sixteenths deep. Starting at zero this was carried around in a complete circle until we arrived at zero again, when the position of the cutter was shifted in three-quarters of an inch, and another row of teeth was cut on this diameter and continued around to give the required number. A groove H was turned on the circumference of the plate. It will be noticed that the plate is nearly four times the diameter of the range dial, so that an error in the plate is reduced four to one.

THE GRADUATING MECHANISM.

The lever I is made with one edge, is 0.03 inch off center, and parallel to the center line with a handle on the outer end, and bored for the bolt J which clamps the dial in the plate, and serves as a bearing for the lever. K is a sliding pawl which engages the teeth G, so that it will slide along groove L and engage either the inner or outer row of teeth. M is a gib lock that engages in groove H for holding the lever. At N a place is milled through the lever for slide O. P is a pin fastened to slide O and engaging in spiral groove D of the dial. As the lever is rotated around the center, the pin causes the slide O to move out or in according to the direction in which the lever is moved. To the slide O is secured another slide Q on which the tool carrier R travels. The tool S is circular, about 2 inches in diameter.

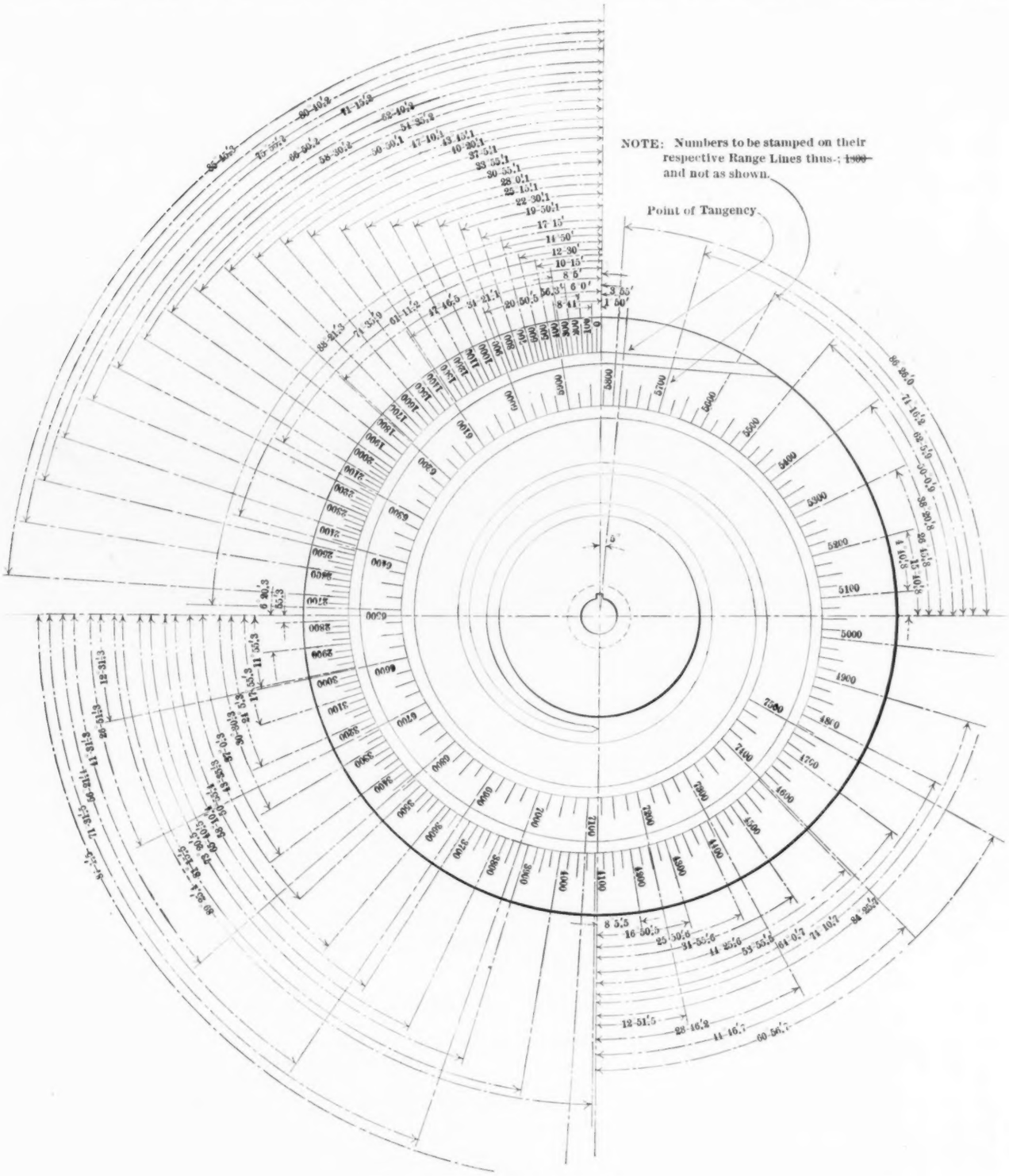

FIG. 2. THE DIAL TO BE GRADUATED.

and 3/8 inch thick. The center of the *V* of the tool is 0.03 inch from one side, which makes the cutting edge travel on the center line of the dial. The cutter is secured with a taper-head bolt, which allows for adjusting, and is made circular, so that in case of grinding or breaking, it will be possible to continue the cutting without the trouble of measuring or setting the tool.

The tool block is connected with lever *U* by the link *V*. *W* is an 8-sided stop, having a ratchet wheel of eight teeth fastened to its side. A pawl engages the ratchet at every full movement of the lever *U*. The pin at the end of the tool box brings up against the stop *W* on the reverse motion of the lever, thus determining the length of the line. Obviously it is only a question of how fast one can pull the levers without making a mistake. We find it better to start on the inner mark and work out to zero.

It will be noticed by Fig. 2 that the intervals change at 2000 yards from 25 to 50 yards, calling for two intermediate divisions instead of four. As the stop was made for four different lengths of lines, this seemed something of a problem at first; but the solution was very simple, for I found on coming to these divisions that the desired results could be obtained by moving lever *U* twice to lever *I* once.

A cast-iron ring was turned up, leaving a small flange on the outside to keep the steel plate in place, and three legs made a very suitable stand for a good machine.

Since making this machine we have received orders for a new type of sight, the 4-inch Mk. xvii, which calls for a different style of dial and different graduations. By turning the steel plate over and using the under side we obtained our master dial for this type at a nominal cost and can, should the occasion require, use the edges for two more types.

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MOTOR-CAR CYLINDER FOUNDING—III

Output Increased by Use of Individual Piston Flasks and Cope Cores—A Solid Wax Core Which Gives an Open Vent—Other Methods of Reducing Labor Costs

BY HUGH DOLNAR

The Manufacturer's Foundry, Waterbury, Conn., occupies buildings carefully designed for the economical production of medium-weight machine castings in gray iron and is a large maker of car-motor cylinders and pistons. The buildings are of brick, lantern roof, with a traveling crane over the main floor, and the core-oven is close alongside this principal floor, chain hoists being arranged so that the larger cores can be transferred directly from the oven cars to the traveling crane. All power is transformed, the fan is electric driven, and the lighting is unusually good by day, with electric illumination as required.

The molding machine is used for making pistons, and other molding machines are soon to be placed, so that the labor costs can be reduced as much as may be. At present the cylinder molding is hand work and the cylinders are all poured in green sand. Many wooden flasks are used, but a considerable number of cylinders are put up in cylindrical iron flasks.

The common practice in piston founding is to put up two molds with two patterns in each rectangular flask, the pistons being poured heads down, and the insides shaped on dry sand cores, one molder putting up 40 or 50 pistons per day.

The Manufacturer's Foundry uses small cylindrical flasks for pistons, with machine molding, and does not desire to have the day's work output of pistons stated. It is largely in excess of the number when made two pistons in one flask.

VENTING THE CORES.

The most important detail of the dry-sand core is its venting, because no matter how accurate the core form may be, sound castings cannot be produced without ample and unobstructed core vents. Core vents are commonly formed by rods, or by strings coated with wax, withdrawn from the cores before or after baking, so as to leave holes through which gas and vapor may escape while melted iron is poured into the molds.

The Manufacturer's Foundry has adopted all-wax core vents. The warmed wax is placed in a cylinder having a small hole in its bottom, and a piston is forced by a screw and hand wheel on the wax, which escapes in the form of a long, continuous cylinder of small diameter and is received in a bucket of water, where it coils itself as produced. This wax core vent is pinched off in suitable lengths and laid in the body of the core in process of forming in the core box. When the core is baked the wax melts and is absorbed by the adjacent sand, leaving a clean, smooth hole in the core body.

The mold and core-setting selected for illustration are for producing the cylinders of one of the best known American cars, name withheld; the Manufacturer's Foundry now has next season's order for 10,000 of these cylinders.

MOLDING DETAILS.

Fig. 1 shows the pattern for this cylinder in place on the follow board. The pattern is divided crosswise, and the flange and open cylinder end pattern is shown as lifted up from the pattern body. The top member of the pattern lies on the right-hand corner of the follow board, which

FIG. 1. COMPLETE PATTERN OF CYLINDER.

FIG. 2. MOLDS COMPLETE AND IN PARTS.

has the runner and gate patterns fixed to it. The cores are shown variously distributed about the follow board.

Fig. 2 shows the drag of the mold in the middle front, the top face of the cheek at the right, and the bottom face of the cope at the left. A row of similar three-part molds is shown stretching from the front to the upper right of the picture. The practice is to first mold the day's work, leaving the molds closed, and then open the molds by taking off the cope only, to permit core-setting, which can be performed without removing the cheek from the drag. In Fig. 2 the cheek is lifted off the drag to show the top surface of the lower mold member.

USE OF BRIDGE CORES.

Fig. 3 shows the top of the cheek with the first core set. The runner basins and gates are shown, right and left of the core. These basin cavities have prints for the bridge cores; the melted iron comes down at the front end of the basin and then passes under the riser hole, and finally meets the bridge core, underneath which it must pass and rise into the gate. The object of this elaborate diversion of the melted iron from an unobstructed path from the ladle to the work mold is to cause impurities to rise in the riser, while the clean, heavy iron flows underneath the bridge, rises in the gate and passes on to the cylinder mold.

Fig. 4 shows the same mold face, with the lower half of the water-jacket core set and the two gate bridge cores in their places. The passage from the riser basin to the gate can be seen under the right-hand bridge core.

Fig. 5 shows the same mold face, with the barrel core set in place and the top member of the water-jacket core lying at the right side of the flask, and the two valve-chamber cores standing at the left, on top of the mold.

Fig. 6 shows the same mold face again; the top part of the water-jacket core has had its meeting edge pasted, set in place and squeezed home by the hand of the molder. The two valve-chamber cores are set about where they will stand in the completed mold. In practice these two small round cores are hung up in the two core prints seen in the cope lower face in Fig. 2, and would not appear at all in this picture. The top part of the water-jacket core is pasted to the lower part with wet paste, which is dried by the use of a plumber's gasolene torch. In this picture the torch flame is shown as directed over the top of the core, because the photograph required exposure time enough to make the flame burn the core, had the flame been directed, as in practice, to dry the wet paste in the water-jacket cores joining. Drying the paste completes this part of the mold. The valve-chamber cores are set in their prints in the cope lower face, and the cope can then be closed on top of the cheek, completing the mold, except for the strainers.

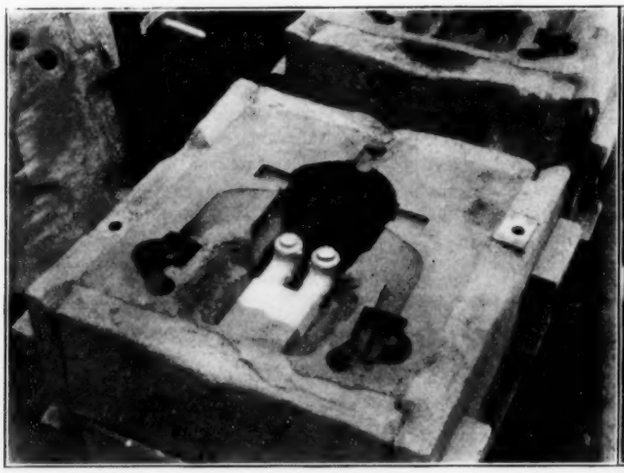


FIG. 3. TOP OF CHEEK WITH FIRST CORE SET.

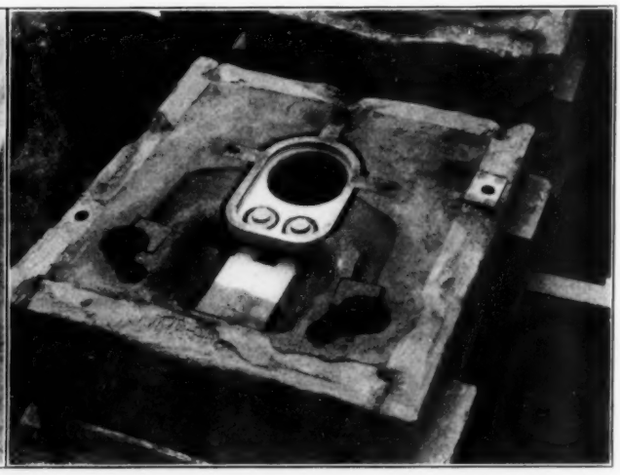


FIG. 4. LOWER HALF OF JACKET CORE SET AND GATE BRIDGE CORES IN PLACE.

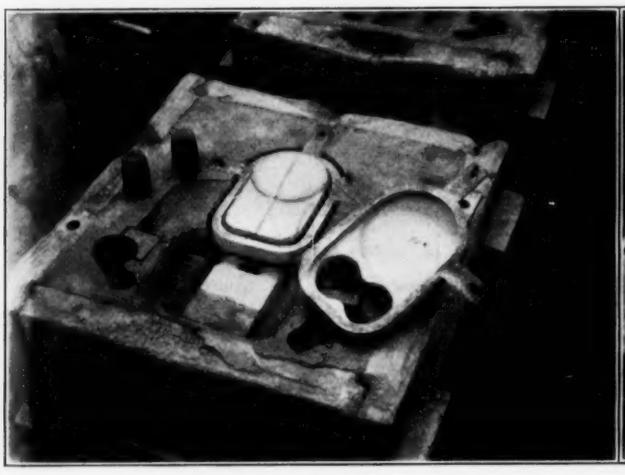


FIG. 5. BARREL CORE SET.

FIG. 6. TOP PART OF JACKET CORE SET, TORCH IN USE.

USE OF STRAINERS.

Fig. 7 shows the pouring basin, formed in the sand, in the top of the cope, with the sheet-tin perforated strainers laid over the two runner or sprue holes, wire-nail retained, as shown at the right, by pushing a small wire nail into the sand, the head of the nail being pressed down on the tin strainer. When the mold is poured the melted iron first enters slowly through the strainer holes, and the iron from the ladle fills the pouring basin about the time the sheet-tin strainers are melted by the iron and disappear, leaving the runner free for the iron to pass downward.

It was formerly the practice in this foundry to use these sheet-tin strainers, which were later abandoned in favor of dry-sand strainers, which are more costly, and are liable to break down and send fragments into the mold, and do not in any case give the final free way into the mold that is opened by the melting of the tin strainers, which are now again the regular practice, the molded dry-sand strainer having been wholly abandoned.

In Fig. 7 one of the tin strainers is shown lying on top of the mold, superfluous, at the top left, placed there to show the full strainer surface in this picture.

Fig. 8 shows the cylindrical iron flasks used for many forms of cylinders. This form, where suitable to the pattern outlines, requires the handling of less sand than the rectangular flasks, exclusively used in many foundries for cylinder molding. The pins and lugs of all these circular flasks of one diameter are alike in form and location, so that any required number of flasks may be used to form a single mold, and the circular flask has several economies peculiar to its form.

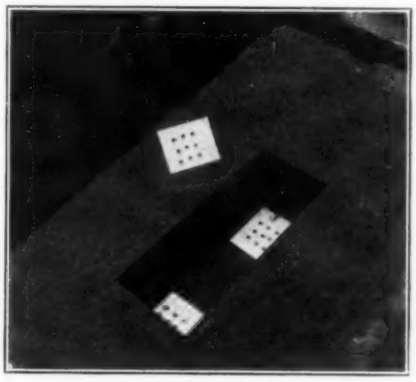


FIG. 7. POURING BASIN WITH TIN STRAINERS.

FIG. 8. CYLINDRICAL FLASKS.

FIG. 9. PISTON FLASKS.

MOLDING PISTONS.

Fig. 9 shows a pile of individual piston flasks, circular in form, of gray iron, with handles at the sides. Ordinary practice uses a rectangular mold and two patterns for each form of piston produced.

The molds are made in a molding machine, no illustration, and appear as shown in Fig. 10, foreground. The trunk-piston core is made with a large flange, which fills the core print in the top of the mold and forms the virtual cope. After the core is set the dry-sand runner basin is set in place, and then a top weight, a rough gray-iron casting with a central opening to pass the runner basin, is set on top of the core flange, all as clearly shown in Fig. 11, a general view of the piston floor.

While permission was given to fully illustrate the piston founding, the precise labor gain was refused for publication. Any foundryman who adopts the method here shown will probably be as much surprised at the lowering of his piston-molding labor rates as I was when told of the labor reduction gained by individual flasks and cope cores, all as fully shown here.

FIG. 10. PISTON MOLDS.

WAX CORE VENTS

The all-wax core vent may be old to many foundrymen, but is new to me and is claimed as original by the Manufacturer's Foundry. The wax-core machine, Fig. 12, is a gray-iron arch with a threaded bronze bush to take a screw with a hand wheel on top and a piston at its lower end. The thick feet of the arch are finished in ledges projecting inside, and the wax-holding cylinder, which the screw-piston fits easily, has a small hole in its bottom and is also flanged top and bottom to slide in on the arch inside ledges. A pail of cold water catches the wax cord as it is forced out at the bottom hole of the cylinder. As soon as the cord touches the bucket bottom the workman picks the end out and hangs it over the bucket edge, and then goes on to screw the piston down, when the wax cord coils itself up floating on the water, all as shown. The wax used is real beeswax, or beeswax and an artificial wax, the name of which is not remembered, somewhat cheaper than the bee product. Wax cores of different diameters are made and are stored by hanging them on wooden pegs on the core-room wall, as shown in Fig. 13. The wax is warmed in warm water and kneaded by the hands before being placed in the cord cylinder, which is of gray iron, finished, and takes flanged discharge nozzles of different diameters through its closed lower end.

The core vent—smooth, clean and surely open—is of the utmost importance, and is obtained much more cheaply by the use of the solid wax core than by the comparatively costly wax-coated string-core vent, and the all-wax core is more easily used by the coremaker, requiring no scissors to cut it to length, and no pulling out after the core is baked, and giving a smooth hole, certainly open at all points.

ANALYSIS.

The Manufacturer's Foundry keeps no chemist, but has a yearly contract with Souther, of Hartford, who analyzes all pig stock and makes a cylinder analysis three times per week. The scrap used is not analyzed and is of all sizes.

Hartford is not far from Waterbury and test samples sent in one day are reported on the following day, so that service is prompt.

According to a local paper, it seems that Stensland, the bank wrecker, was in control of a steel ball manufacturing concern in Chicago, and that he was also dabbling with a new automobile.

MOLDING AND PATTERNMAKING OF AN AUTOMOBILE GAS ENGINE

Comparative Advantages of Two-cycle and Four-cycle Types—Gas Engines Revolutionized by Automobiles—Why Air Furnace is Superior to Cupola and Bay Wood Best Material for Cylinder Patterns—Cooperation of Molders and Patternmakers Essential for Best Results

BY E. F. LAKE

The gas engine is divided into two types. These two classes are the two-cycle and four-cycle. The two-cycle engine gives an explosion of gas which drives the piston at each outward stroke. Each inward stroke drives out the exhaust gases and at the same time draws in the fresh gas, thus giving a power stroke at each revolution of the crank shaft. This is accomplished by many manufacturers without the use of valves and is then called the valveless engine; other manufacturers make use of one valve, where the gas is taken into the cylinder. The two-cycle principle is used largely on marine engines, although a few prominent automobile manufacturers have adopted the two-cycle engine, as it does away with a great deal of mechanism necessary to operate a four-cycle engine, such as cams, cam shafts, valve rods, valve springs and the valves themselves, which must be reground and replaced when they are worn.

The four-cycle engine explodes the gas when the piston is at the inner end of the cylinder; this forces it to the other end of the cylinder; on coming in again, it drives the exhaust gases out of the cylinder; on its next outward stroke it sucks in the fresh gases and on its inward stroke it compresses the gas, which is fired when the piston is at the inner end. This gives a power stroke at every other revolution of the crank shaft.

The four-cycle principle is used by some in marine engines and is used by about 90 per cent. of the automobile manufacturers; as, owing to the explosions being less frequent, it is easier to keep the cylinders cool, and there is not the liability to premature and crank-case explosions owing to the exhaust gases and the fresh gases being kept separated, which is almost impossible in the two-cycle engine, as the exhaust and intake of gas occur at the same time and the fresh gas is relied on to drive the burnt gases out.

FIG. 12. WAX CORE VENT MACHINE.

Another great difference in gas engines is the method of cooling the cylinders. The continual explosions of the gases in the compression chamber cause the cylinders to heat rapidly and if some means is not adopted to keep them cool the gases would become ignited as soon as they entered the compression chamber and before the piston had come to the top of the cylinder which would cause the engine to stall. There are two systems in vogue for cooling, one is by sending a steady stream of water around the cylinder, for which a water jacket is provided. The other is by a current of air being directed against the cylinder for which numerous thin flanges are placed around and top of the cylinder. These are respectively called water-cooled and air-cooled engines. The water-cooled system is used on nearly all of the two-cycle engines and on about 75 per cent. of the four-cycle, although the air-cooled engine seems to be growing in favor for automobile use, as the automobile being on the move when the engine is, it is not a hard problem to give the cylinders a sufficient current of cooling air. This is done either by placing fans where they will direct the air against the cylinders or by covering the cylinders with a sheet-metal case and forcing a current of air through that.

The growth of the automobile business has almost revolutionized the gas-engine business in that it has demanded light weight in connection with great power to drive the cars at high rates of speed. Some touring cars are geared to run as high as 60 miles per hour, to say nothing of the racing cars which have made two miles in less than one minute. Where before the advent of the automobile about 40 pounds per horse-power was the rule for gas engines and was considered as light as it was safe to make them, now about 15 to 20 pounds per horse-power is the general rule and they have been built as light as 10 pounds per horse-power for automobile use. In the experiments in flying machines, which are going on, they have been built even lighter.

Prof. S. P. Langley, in his experiments with the aerodrome, contracted for one with an American firm to develop 12 horse-power and weigh not more than 100 pounds, or 8 1/3 pounds per horse-power. This contract the manufacturer failed to

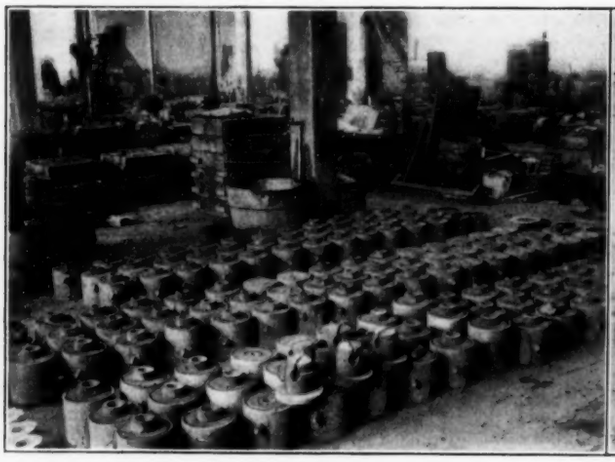


FIG. 11. PISTON FLOOR.

FIG. 13. WAX CORE VENTS.

fill, however, and Professor Langley then built one in the Smithsonian Institute which developed 52 brake horse-power and weighed less than 5 pounds per horse-power, including cooling water, carbureter, battery, etc.

Numerous ways have been adopted to jacket the water-cooled gas engine, such as making the jacket of sheet copper and fastening it to the cylinder with an iron flange and gaskets. One manufacturer in France has cast the part of the cylinder, where the piston and valves have their bearing, of iron, as cast iron is the best known metal to stand the wear of the piston, and by placing this casting in a mold and molding the water jacket around it, then heating the mold with the iron cylinder casting in it to a certain temperature, after which the mold while heated is poured with aluminum, an aluminum water jacket is thus cast on the cast-iron cylinder. The usual way, however, to water jacket the cylinder is to make the jacket and cylinder in one piece, of cast iron. These cylinders are usually cast in pairs for automobile work, that is, two cylinders and their water jacket are cast integral and bolted to a crank case which carries one or more pairs of cylinders, a large majority of the cars being of the four-cylinder type, although some of the racing cars have eight cylinders and one is being brought out this year for the Vanderbilt cup race with 12 cylinders.

In marine work the usual rule is for each cylinder with its water jacket to be cast separate, although some use the double cylinder, while some automobile makers are using the single cylinder, and one manufacturer in this country is using four cylinders cast in one piece.

I have illustrated at Figs. 1, 2 and 3 the two cylinders with their water jacket cast in one piece, as that is the form adopted by a large percentage of the automobile manufacturers. Where the single-cylinder casting or the four cylinders with their water jackets cast integral are used, the problems for the patternmaker and molder to solve are not changed except in details. In the case of the single-cylinder casting the illustration can be cut in two by the reader and in the case of the four cylinders cast integral the illustration can be doubled.

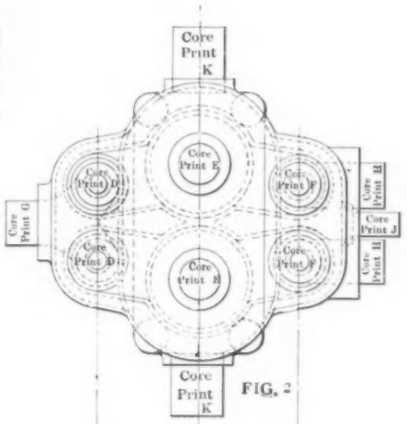


FIG. 2

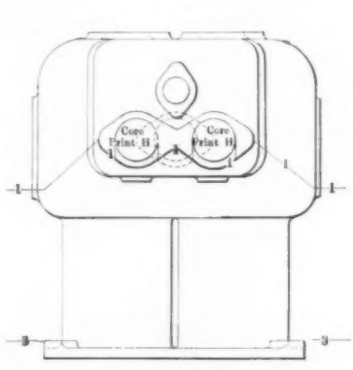


FIG. 1

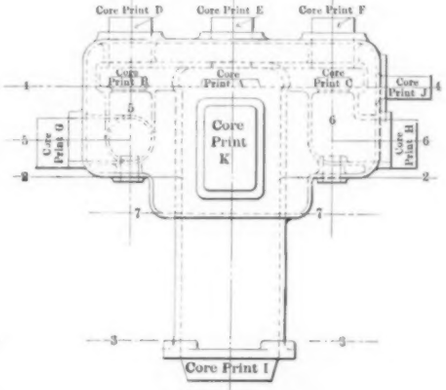


FIG. 3

PATTERN MAKING OF AN AUTOMOBILE GAS ENGINE.

The casting of these cylinders was a difficult problem until the last few years, and many manufacturers had to send to Europe for their cylinder castings. One prominent manufacturer continues to do so. There are now quite a number of iron foundries in this country which are turning out successful castings. The best results seem to come from those who have discarded the old cupola and adopted the air furnace. In the cupola a blast of cold air is forced in at the bottom, and this coming in contact with the melted metal can change the composition of it, owing to some elements in the iron burning more readily than the others, also the wood which starts the fire, and the layers of coke and iron with which the cupola is charged add elements which should not be in the mixture; they also introduce a large amount of cinder which has to be skimmed off. The last iron taken from the cupola being not so good, a cheaper grade of castings has to be provided to use up this poorer metal.

The air furnace has a hearth on which the metal to be melted is placed. It is in the shape of a horizontal box; a high chimney is provided which draws the heat from a furnace over the metal after the oxygen has been combined with the carbon, hence it cannot combine with the metal on the hearth and change its composition by burning out some of its elements or adding others. The iron comes from the furnace just as it is put in, and when the chemist prescribes a certain mixture for a given job, it can be depended on to "deliver the goods," which is not always possible with the cupola. The air furnace works slower than the cupola, and cannot be recharged as the cupola can, hence it is more costly; but where a high grade of iron is required, one that will run even, as in gas-engine cylinders, it is greatly superior to the cupola. In the making of cylinder patterns the selection of woods to build them is an important point, as the changes, alterations and improvements, which are continually being made in the gas engine, do not warrant the use of metal patterns; and as each pattern has to stand up for from 300 to 2000 castings, the use of pine is not a good thing, as it is too soft, and would wear out too soon. The patternmaker has to work within 1-/32 of an inch, or he will hear from the engineering department; for if the metal is too thin in spots, the cylinder is liable to crack; and if it is too thick, the casting will be too heavy, which is also a grievous error in this business. After trying several different kinds of wood, we have found that bay wood (called mahogany by many) is the most suitable as it is hard, has a fine grain, and does not soak up the moisture of the foundry readily, if kept well varnished. This is an important feature on all wood patterns which are in continual use, preventing shrinking and swelling to any extent. Cherry is an equally good wood to use, but is a little harder to work than bay wood.

The designing of the cylinder pattern is an important part, as the pattern will have to be molded the way it is built by the patternmaker. It is always best for the foreman molder and the foreman patternmaker to get together, as each has a knowledge which the other does not possess. By exchanging ideas they can arrive at the best way to mold the job and save time, as every move of the molder and coremaker is multiplied from 300 to 2000 times, according to the number of castings wanted. Where the company does not have its own foundry, it is up to the foreman of the pattern shop to so design the pattern that it will mold the easi-

est and best way. After studying over several ways of making this pattern, as shown in Figs. 1, 2 and 3, it was decided best to mold it as shown. This was agreed to by the foundry foreman when he received the pattern. Another way it could have been molded was to lay it on its side, and put through the core prints *D, E, F* and *D, E, F*, Fig. 2; this would have taken a three-part flask the same as parting it the way we did; but if any air bubbles from the cores, facings, or loose sand, which might be caused by setting the cores, should catch in any of the numerous pockets in the mold, they would cause a bad casting in that part of casting which was in the cope. These foreign substances being lighter than iron rise to the top, and when they cannot pass out through the risers provided by the molder, lodge in the mold, and when molded on both sides, these bad spots would come in the compression chamber, the valve seats, the walls of the cylinder, the water jacket, etc., on one side of the casting, while the side in the drag or nowel would be good iron.

If the pattern is parted on the lines 2, 2 and 3, 3, Fig. 3, it can be drawn from the mold easily. The mold can then be parted on the lines 1, 1, 1, 1, 1, and 3, 3, Fig. 1. The parting at the line 1, 1, 1, 1, 1 being an irregular one it is best to have a match board fitted to the pattern to make the parting, as it will save a good deal of the molder's time in cutting out the sand with a trowel. That part of the casting above the line 1, 1, 1, 1, 1, would then come in the drag or nowel and insure the best iron in the mold in and around the inlet and exhaust valves, the compression chambers and cylinder walls where the piston has its bearing. The part of the pattern between the lines 1, 1, 1, 1, 1 and 3, 3 would be in the cheek and would get good iron although the piston on its down stroke and even when at the lowest point of its travel covers the most of this so that slight defects here would not make so much difference. That part of the pattern below the line 3, 3 would be in the cope and if sandy, porous or bad iron caused by bubbles should occur here, it would not make so much difference as long as there was strength enough in the casting to hold it when bolted to the crank case. Cylinders from this pattern have been cast at the rate of eight per day with a labor force of two molders using two patterns, one core setter who has a helper, and seven coremakers using two sets of core boxes. The losses for bad castings have averaged only 5½ per cent. The designing of the core boxes, deciding where to part the cores so that the core setter can set them to the best advantage, is a much more difficult problem than the making of the pattern. In this case the cores had to be parted at a different place from the pattern. In order to get the compression-chamber core in it was necessary to part the water-jacket core on the line 4, 4, Fig. 3. In order to get the inlet passage core in at the core print *G*, the water-jacket cores had to be split on the line, 5, 5, Fig. 3. To get the two exhaust-opening cores in at core prints *H H*, the water-jacket core had to be split on the line, 6, 6, Fig. 3.

The cores would then be set in this order. The first core to be set would be the one that cuts the opening into the water jacket for the cooling water to enter at core print *J*. Then the water-jacket core above the line 4, 4, Fig. 3, would be placed in the drag and located by the core prints, *E E;* after that the core forming the compression chamber above the line 4, 4 would be lowered through the water-jacket core at the prints *D, D* and *F, F* and located by these prints, which form the opening for the removal or regrinding of the valves. Next that part of the water-jacket core between the lines 5, 5 and 4, 4 and 6, 6 and 4, 4 is placed in position and pasted to the water-jacket core which has already been placed in the mold. Then the core forming the inlet passages for the gas is put in and located by the core prints *B, B* in the compression-chamber core (only one of which is shown in Fig. 3) and the core print *G* in the mold. The cores on the opposite side of the mold, which form the exhaust openings, are then set and located by the core prints *C, C* and *H, H*, Fig. 3. The core-prints *H, H* and *G* are made with a tail to bring them to the top of the gland bearing so that the parting of the pattern will be made easier, shown at 1, 1 Fig. 1. The main part of the water-jacket core between the lines 4, 4 and 7, 7 Fig. 3 is then placed in the mold and wired and pasted to the other pieces of the core which are in; this is located by the core-prints *K, K* which are made extra long to support and balance the core. The cores which form the cylinder walls are then tried in, and located in the core-prints *A, A* in the compression-chamber core, to see that everything is all right. When assured of this they are taken out, the cheek of the mold is fastened to the drag, the piston-chamber cores are replaced and the cope is placed on, which holds the piston-chamber core in position by closing down over the core-print *I*, Fig. 3. The mold is then clamped together; the cracks pasted up with fine clay; the pouring and riser boxes which are lined with sand are placed on top; the cords which have protected the vent holes in the cores and have been brought to the top of the mold to insure good venting are then pulled out of the mold and a cast-iron box is placed around the opening thus left to prevent sand falling in, or hot iron splashing in when pouring. This completes the mold and it is ready to pour.

The highest grade of skilled labor is required in making these cores, as well as in the molding and pattern-making, as they are very thin in places and must be made strong enough to be handled in making, baking and setting, and at the same time must be made so that they will crush when the casting begins to shrink in the mold when cooling. They must also be as porous as possible so that the gases which are generated will pass off freely.

Test pieces are cast of the same iron as the cylinders, these are tested and a chemical analysis is made in order to make sure that the iron contains the right ingredients.

Engineering Ethics.

Our contemporary, *Engineering News*, devotes a good deal of space to the ethics of civil engineering, and its readers seem to be interested in the question of what is right and proper for an engineer to do, and what he should not do. We commend for discussion in its columns the trick charged against the chief engineer of the Lackawanna railroad, by means of which the taxpayers of Newark, N. J., are alleged to have been cheated out of many thousands of dollars. The story, as published by a local paper, is that, securing an agreement to the principle that the city should pay a portion of the cost of the elimination of grade crossings within the city, the engineer then made an estimate of the cost of the work, which estimate he knew to be, and which actually was, far in excess of the real cost. The city authorized the payment of a sum based upon this false estimate, and, having secured the money, the engineer snaps his fingers at the city, and felicitates himself upon the success of his trick. Discussion of this case might perhaps profitably include not only its moral and ethical aspects, but also the question as to whether or not a road in the end gains anything by such sharp practice. We think it is very doubtful.

W. E. Gould, 142 Hazelwood avenue, Detroit, Mich., sends us a sample table of decimal equivalents, which is printed on specially prepared celluloid of a size convenient for the pocket, and in which the common fractions are arranged in separate vertical columns, in accordance with their denominators, so that the decimal equivalent of any fraction of an inch is very readily found, while at the same time the proper sequence of the different fractions is preserved.

According to a writer in the *Chicago Record Herald*, the Metropolitan Life Insurance Company proposes to build a tower 700 feet high for offices and painters' studios on the site of Dr. Parkhurst's church on Madison Square, opposite Fifth Avenue and Twenty-fourth street, New York City. It will cost $1,500,000, and will be 308 feet taller than the tower of Madison Square Garden, which is a duplicate of the famous Giralda at Seville and 332 feet high. It will also be 145 feet taller than the Washington monument, which is 555 feet and, at present, the tallest human structure in the world.

Smoke and Its Abatement.*

By CHAS. H. BENJAMIN, Cleveland, O.

1. The subject of this paper is one which was suggested by the Secretary of this Society during the past year, and is, or ought to be, of general interest at the present time. The smoke nuisance has long been one of the bugbears of living in the middle West and is now rapidly becoming an important factor in the East. It is so much easier to keep this nuisance out than to get rid of it when once in, that the residents of cities on the Atlantic seaboard ought to be alive to the situation.

2. The fact might as well be recognized at once that the supply of so-called smokeless fuels, anthracite coal, petroleum, natural gas, etc., is limited and will not begin to satisfy the demand. The supply of bituminous coal on the other hand is practically unlimited, and it is doubtless the fuel of the future. The abundance of it, its cheapness and the readiness with which it burns, even with a poor draft, combine to make it a most desirable fuel.

3. This granted, the further fact remains that it will be burned to a larger and larger extent in the East as well as in the West and that no legistalion can prevent this.

4. Just as anthracite coal becomes more scarce and its price increases, just so surely will its place be taken by the cheaper and more abundant fuel.

5. The problem for our engineers and lawmakers is not how to prevent the burning of soft coal, but how to burn it in such a way that the combustion shall not be a public nuisance.

6. Unfortunately this, our best fuel, is at the same time our dirtiest fuel both in the handling and in the burning.

7. The smoke from most other fuels, while not suitable for the lungs of human beings, is, if carried to a sufficient height by a chimney, comparatively inoffensive, since it does not return to earth.

8. The present discussion will then be confined to the problem of abating the smoke from bituminous coal.

9. The word abatement is chosen with a reason and the terms smoke prevention and smoke burning are discarded.

10. It is not practicable to prevent the evil entirely, but only to mitigate it in a degree. Smoke burning on the other hand is an impossibility under the conditions which usually present themselves.

11. During my somewhat strenuous experience as city smoke official I encountered two extreme types of unbelievers.

12. One was the private citizen who did not believe that manufacturers had any rights in the premises and who clamored for instant prosecution. The other was the manufacturer who considered that smoke was an index of prosperity and regarded any criticism or interference as malicious persecution. Between these two extremes were all sorts and conditions of men, some belligerent, some indifferent, some interested, but nearly all destitute of any appreciation of the true nature of smoke or the means of its abatement.

13. I would not jeopardize my standing in this Society by insinuating that there are any such present.

14. It will be well at the outset to state three propositions: *a*. The smoke from bituminous coal is a nuisance, especially in large cities. *b*. Such smoke can in the majority of cases be easily abated. *c*. Such abatement can be made a source of profit to the owner of the plant as well as to the community.

15. There need be no difficulty in establishing these propositions by precept and by example.

16. Objectionable black smoke is due to the presence of hyrdocarbons in the fuel and is produced as follows: The hydrogen and carbon compounds in the coal are driven off as gas by the heat at a comparatively low temperature, and may escape unburned. In this condition they would not constitute smoke in the common sense of the term. If heated to a sufficiently high temperature in the presence of air they burn with a yellow flame. If the air supply is insufficient, is poorly mixed with gas, or if the temperature is lowered in any way, combustion is checked and carbon is deposited in the form of soot or carried off with the gas as smoke.

I cannot illustrate this better than by quoting from a paper read before the American Association for the Advancement of Science.*

> The combustion of hydrocarbons seems to be always complete at first. If one watches the slow burning of a lump of cannel in the open grate he will see a whitish or yellowish vapor expelled from the coal by the gradual heat of the fire. This is the carbon and hydrogen combined which is distilled by the heat and leaves behind the free carbon as coke. While the escape of this vapor unburned represents a distinct loss of heat, the vapor is not smoke as we understand it. It does not deposit soot and will not stain or disfigure surfaces in its path.
>
> As the heat increases, and air is supplied, the vapor ignites and burns with a yellow flame showing the presence of solid particles. If the temperature remains high and the air supply continues, the combustion is complete and the colorless carbon dioxide and water vapor pass up the chimney. If, however, the burning gas becomes chilled by contact with the relatively cool bricks of the chimney back or if insufficient air is supplied, the yellow flame becomes red and dingy, while particles of finely divided carbon are deposited on the adjacent surfaces or whirled away up the chimney.
>
> The ordinary coal-oil lamp is one of the best illustrations of perfect combustion and consequent smoke prevention. The heated gases rising in the chimney produce a draft and fresh air is continually drawn in at the bottom through the hot gauze which warms and divides it so as to insure thorough mixing with the gases from the burning oil. Turn up the wick and the flame becomes smoky—too much hydrocarbon for the air supply. Raise the chimney slightly from the bottom and again there is smoke—too much air at too low a temperature which chills the flame. Insert a cool metal rod into the chimney and soot is deposited on it—chilling of the flame again and disengagement of the carbon, while the hydrogen continues to burn.
>
> And thus we may learn of the three requisites for good combustion: enough air, a sustained high temperature and a thorough mixing of the gases. The last two are so important that it is entirely possible to have an excessive supply of air and dense black smoke at the same time.

Science, March 25, 1904.

17. It is difficult to form any estimate of the amount of damage inflicted by soft coal smoke in a city like Pittsburg or Cleveland, but it probably amounts to hundreds of thousands of dollars annually.

18. The deterioration of dry-goods, draperies and delicate fabrics on the shelves and counters and in the show-windows is a direct tax on the buyer. In the book trade the situation is perhaps worse. I remember seeing in a display window in Chicago an assortment of valuable books, most of them open to view and all of them so streaked and spotted with soot as to render them unsalable at any decent price. Our libraries, public and private, are suffering day by day, and our art collections grow more and more dingy. Cleveland can produce an old master "while you wait."

19. One of the largest items of annual expense in the city hotel or club-house is that of cleaning draperies, rugs and furnishings, and of redecorating walls and ceilings. A great part of this is directly chargeable to coal smoke.

20. The presence of more or less sulphur in the soot renders it a corrosive as well as a discoloring agent and greatly increases the damage done. Trees and shrubs suffer in such an atmosphere and are frequently killed outright by the presence of sulphurous smoke. The effect on human beings has not been definitely determined, but the deposition of soot on the delicate tissues of the respiratory organs can hardly be beneficial.

21. In law a nuisance is "such a use of property or such a course of conduct as, irrespective of actual trespass against others or of malicious or actual criminal intent, transgresses the just restrictions upon use or conduct which the proximity of other persons or property in civilized communities imposes upon what would otherwise be rightful freedom." (Century Dictionary.)

22. Smoke is then a nuisance and can be prohibited by State or municipal enactment as the case may be.

23. I have no more right to deluge my neighbor's premises with soot than I have to empty my garbage can over the fence line.

24. The abatement of smoke is in principle extremely simple, but presents some difficulties in the practical application.

25. Only three conditions are necessary for complete combustion, the proper temperature, the proper air supply, a thorough mixing of the air and the hydrocarbons.

26. The last condition is as important as any and is one too often neglected.

27. It is this condition which gives the gas or liquid hydrocarbon an advantage over the solid, since the atomizing of the former by the steam or air jet insures the most intimate contact between the air and the fuel.

*Presented at a meeting (June, 1905) of the American Society of Mechanical Engineers, and forming part of Vol. XXVI. of the *Transactions*.

28. The use of pulverized coal in combination with air or steam is a close approximation to the above, and, when properly managed, gives good combustion, no smoke and a high efficiency. The cost of pulverizing and the impracticability of storing pulverized fuel have so far hindered the more general adoption of this process, except for metallurgical work.

29. When coal in the ordinary form is used as a fuel, smoke abatement involves some means of varying the coal supply and the air supply according to the demands made upon the boiler. When ordinary hand firing is restored to, the great irregularity of the coal supply will cause poor combustion and smoke unless the air supply is varied to correspond. Steam jets are frequently employed under these circumstances, and, if properly put in, will improve the combustion by drawing in additional air over the grate and mixing it with the products of combustion in front of the bridge wall. The steam jet should be semi-automatic, the steam and air being turned on by the opening of the fire door and gradually closed off by a dash-pot attachment.

30. The best solution of the smoke problem, so far, has come from the introduction of mechanical means of handling the coal, which gives the uniform feed to the fuel and a corresponding delivery of air for combustion.

31. The use of mechanical stokers has been brought about by the natural demand for machine handling in large power plants as more economical than human labor, rather than by a philanthropic desire to benefit the community.

32. It has been estimated that one able-bodied man with a shovel and slice-bar can take care of 200 horse-power of boilers. With good mechanical stokers he can handle double, and with complete coal and ash-handling equipment three times this amount.

33. Stokers may be divided into three principal classes: Inclined, shaking grates—traveling or chain grates—and underfeed stokers.

34. The inclined grate, as exemplified in the Wilkinson, Brightman and Roney stokers, has a hopper in front and slopes down and back, having a clinker grate just in front of the bridge wall, while the double incline, as in the Murphy and Detroit stokers, has a magazine on either side and slopes in two planes parallel to the axis of the boiler, meeting in a clinker grate at the bottom. The principle of action is practically the same and involves the slow coking of the coal on a dead-plate, the pushing forward on to the top of the incline and the gradual descent, impelled by oscillation of the grate bars, until the combustion has left nothing but ash and clinker at the bottom. Air is usually admitted both below and above the grate, and the hydrocarbons which are distilled at the top of the grates pass through the intense heat of the burning coke on their way to the bridge wall and are completely burned. The double incline usually has a revolving clinker bar which disposes of some of the ash automatically, but as a rule both forms need considerable cleaning.

35. When used with a fuel which does not cake or clinker too much and when not crowded too hard these stokers are economical and reduce the smoke considerably.

36. If, however, it becomes necessary to slice and poke the fire on account of caking coal or overcrowded boilers, unburned masses of coal are rolled to the bottom and holes are made in the fire through which cold air rushes. Both of these circumstances make for poor combustion and a smoky fire. As a rule firemen poke the fire on stokers too much, doing more harm than good.

37. I have seen inclined grate stokers, carrying a heavy fire and developing much more than the rated capacity of the boiler with very little slicing and hardly a trace of smoke. Cleaning is usually a source of black smoke for a few minutes, but this is mostly unnecessary if the fireman understands his business and gets his fire ready for cleaning before hand. I think the middle door in the Murphy furnace is sometimes a disadvantage, as it tempts the fireman to meddle with the fire when he had much better leave it alone.

38. The traveling or chain grate is rapidly coming into favor as a means of stoking automatically. It consists, as in the Babcock & Wilcox and Green stokers, of an endless horizontal chain running on sprocket wheels and carrying the coal back under the boiler, finally dumping the refuse over the back and into the ash-pit. The distilling process and the gradual burning of the coke are much the same as in the stokers just described. In order to prevent waste through the grates the latter are usually quite close, and it becomes necessary to use more draft than with ordinary grates.

39. A damper is used underneath the grate to prevent an excess of air from passing up behind the grate. Some tests recently made by a large corporation which uses a considerable number of the chain grates showed an evaporation of only 5.7 pounds of water per pound of coal. An examination disclosed the fact that a large excess of air was passing through the comparatively bare grate at the rear end. The introduction of a damper to regulate this brought about a great improvement.

40. With the same fuel and same conditions as before an evaporation of 8 pounds of water per pound of coal was obtained.

41. Intending users of chain grates would do well to bear this in mind.

42. From observations covering a period of several years I have come to the conclusion that this type of grate is the best one yet devised for abating smoke.

43. The fact that it is horizontal, so that unburned coal cannot run to the rear end, and the further fact that it is self-cleaning and need not be disturbed by the slice-bar, make it an almost ideal furnace in this respect.

44. If run by an intelligent fireman who undertands adapting the depth and travel of the fire to the work to be done, it will also be a very economical furnace.

45. The underfeed stokers operate on an entirely different principle, the coal being fed in underneath the grate and forced up through a rectangular opening in the center. A forced blast is used and the air for combustion is blown up through the coal, the tuyeres being on either side of the rectangular opening just mentioned. By this arrangement the fresh coal is always underneath and the distilled gases are obliged to pass through an incandescent mass of fuel in company with the air. With a proper pressure of blast perfect combustion is thus almost unavoidable. The ash and clinker are now at the top of the fuel, which forms a gradually rising mound in the center and pushes the clinker over to either side, whence it is removed by hooks through doors at the front. The heat generated is such that the ash generally melts and forms a sheet of clinker which can be easily removed without disturbing the fire.

46. In the American stoker the coal is forced under the grate and up by a revolving screw, somewhat simular in shape to the ordinary gimlet pointed lag screw.

47. In the Jones underfeed stoker a plunger driven by steam operates to feed the coal. This plunger can be arranged to start and stop by hand or to run automatically.

48. My experience has shown the underfeed stoker to be economical in operation and practically smokeless.

49. A criticism frequently made in regard to mechanical stokers is that they will not respond quickly to sudden changes in the load, that it is difficult to keep a uniform steam-pressure under such circumstances, and that for this reason they are not economical. There is some truth in this. It is easy to conceive of circumstances, especially in electric plants, under which it would be difficult to maintain a uniform steam pressure with either the oscillating or the traveling grate.

50. For regular fluctuation of load, as in electric lighting or railway powerhouses, the obvious remedy is the introduction of storage batteries and the provision for ample boiler reserve.

51. Minor fluctuations can be taken care of by the fireman unless they become too numerous or too violent. In the latter case the underfeed stoker with the plunger feed comes the nearest to satisfying the demand. With the power of

instantly regulating the motion of the plunger and the pressure of the blast, it is thus possible to meet emergencies of this kind more promptly than by hand firing.

52. With the complaint sometimes made that stokers cannot be forced I have no sympathy. With an ordinary inclined grate stoker under a horizontal tubular boiler I have forced a boiler to seventy-five per cent. above its rating with practically no smoke and with an evaporation of over 8 pounds of water per pound of bituminous slack. It all depends upon the draft and upon the intelligence of the fireman.

53. Probably, however, none of us believe in forcing a boiler to this extent; it is bad for the boiler, bad for the stoker and bad for the coal pile.

54. The economy resulting from the abatement of smoke is naturally a potent argument in its favor.

55. This phase of the subject has, however, but little to do with the ethics of the question. Once prove that it is practicable to abate smoke and the community has a right to insist on its abatement regardless of economical considerations.

56. It may cost me more to haul away my garbage than to throw it into my neighbor's yard, but that is no argument for my imposing upon my neighbor.

57. Fortunately this difficulty does not exist in most cases, for it may be stated as a general proposition that smoke abatement means economy in fuel consumption. The proof of this statement is extremely simple: fuel economy results from good combustion, good combustion is accompanied by little visible smoke.

58. It must be remembered that the converse is not necessarily true, for a smokeless chimney does not always mean good economy.

59. An excess of air may insure entire oxidation of the combustible matter and at the same time so dilute the chimney gases as to cause serious waste of heat.

60. The problem to be studied by the manufacturer should be how to obtain the most perfect combustion of the particular fuel which he uses and then the smoke question will take care of itself. Let him make frequent analyses of chimney gases, compare different pressures of draft and different dispositions of dampers and he will be repaid for his trouble in more ways than one.

61. Personally I believe in the automatic stoker as the most economical solution of the problem.

62. In forming this opinion I do not rely upon expert tests for efficiency; there are so many variables entering into the question that it is difficult to make accurate comparisons in this way. As it is entirely possible to improve the efficiency of a furnace ten or fifteen per cent. by intelligent hand firing, there is much difficulty in determining the actual saving affected by a stoker. During a competitive test between the hand-fired furnace and the stoker the conditions are often entirely different from those obtaining in every-day use, and these changed conditions are usually more to the advantage of the hand firing.

63. By this I mean that good hand firing is the exception rather than the rule, on account of the dirty, disagreeable nature of the work and the low grade of help employed.

64. With the introduction of mechanical handling there is a reduction in the quantity of manual labor and there should be an improvement in its quality. Manufacturers should understand that if they expect to get the benefit of improved machinery they must have men competent to run it to the best advantage.

65. The surest method of determining the relative economy of the two methods is by comparing the coal bills before and after the change, making due allowance for any variation in the work done. This has been done in a number of instances to my knowledge and the result has always been favorable to the stoker. About a year ago I addressed letters to a number of business men and manufacturers who have installed mechanical stokers of various sorts in factories and office buildings, asking for information as to the value as smoke-abating devices of the particular stokers used, and as to the fuel economy and the cost of repairs.

66. The replies in every case were favorable to the stoker, both as regards smoke abatement and as regards general efficiency. There are in the city of Cleveland fifteen large office buildings, ranging from eight to sixteen stories in height, which have mechanical stokers in connection with their power and heating plants. It is doubtful if any such building will be erected in Cleveland in the future without an equipment of this sort.

67. One manager of a ten-story office building writes that he has three 200-horse-power stokers which have been in use for four years burning slack coal, and that the only repairs have been the replacing of brick linings at a total expense for the four years of only fifty dollars per furnace.

68. The following quotation from a letter written by the manager of a large storage warehouse explains itself:

"We installed under our four boilers stokers known as the ———, and they all went into service on March 1, 1903.

69. "Our chief object in installing the stokers was to abate the smoke, and this they accomplished to such an extent that our chimneys are practically smokeless, and in addition to this we saved 500 tons of coal for the year. This we think is a fair showing, and thus far we have been put to very little expense in keeping them in repair."

70. An extract from another letter is as follows: "The stokers cost approximately $1,500. The annual saving of fuel is $550. The demand for steam is increased ten to fifteen per cent."

71. Personal letters from well-known business men in Cleveland testify to a saving in fuel varying from fifteen to twenty-five per cent. A very conservative letter from the chief engineer of one of the largest power-house in the city contains some criticisms of faults in the various stokers used, but concludes as follows: "While it is impossible for me to ignore the weaknesses in the above stokers, yet I would certainly recommend the use of either of these stokers over hand-firing in a plant of any size using bituminous coal."

72. The business policy of some of the largest corporations forbids letters of commendation for any mechanical device whatsoever, but I am in position to know that exhaustive tests covering a period of months have shown the economy of the new way in a most satisfactory manner. This is further evidenced by the fact that these "soulless corporations" are changing to the mechanical stoking as rapidly as the pressure of business will allow.

73. One suburb of Cleveland containing large steel works has been redeemed in the most remarkable manner by the introduction of automatic stokers, so that there is now a place for human beings to live, where formerly all was soot and blackness. The president of a manufacturing company using four stokers reports that he is not only paying from fifty to seventy-five cents less per ton for his fuel, but is burning six tons less per day than formerly, and at the same time getting better satisfaction in the maintaining of a uniform steam pressure.

74. It is undoubtedly true that the agents of smoke-abating devices of all sorts have been extravagant in their claims and that they have damaged their own business by such claims, but this is a mistake not confined to the furnace business.

75. A conservative claim of from ten to twenty per cent. saving, depending upon how smoky the furnace has been, can usually be substantiated by a comparison of the coal bills before and after introducing stokers, without resorting to expert tests. I have known so simple a thing as an automatic steam and air jet to pay from 50 to 100 per cent. annually on the original investment, as determined by the coal bills.

For the benefit of those who rely largely upon expert tests for their opinions, I introduce a summary of several such tests which have come under my personal observation.

Tests 1 and 2 show the improvement made by more careful handling of the stokers, while 2 and 3 illustrate the advantage of overloading rather than underloading the plant.

In test 2 only twelve boilers were used and in test 3 the number was increased to

fifteen, the load being nearly the same. The poor showing in test 1 was due principally to waste of coal in the ash.

Tests 5 and 6 show the improved results from stokers as compared with hand firing under a heavy overload, while Nos. 7 and 8 give the results of similar tests on Scotch boilers. No. 9 was an acceptance test for a city plant, conducted by trustworthy and experienced engineers.

No. 10 is introduced to show how not to do it. Not only is the ash high, showing poor judgment in running the stoker, but actual measurement proved the air-supply to be excessive, about 350 cubic feet per pound of coal burned.

With induced draft such as was used in this test it should be possible to get along with from 200 to 250 cubic feet of air per pound of coal. Tests 11 and 12 show the possibility of carrying an overload with a chain grate, using a poor quality of coal and getting better results than could be obtained with a better quality of coal hand fired.

No.	Kind of Boiler	Kind of Stoker.	Boiler H. P.		Kind of Coal	Per Cent. of Ash	Evaporation from and at 212°	
			Rated	Developed			Per lb. Dry Coal	Per lb. Combustible
1	Return Tub'lar	Murphy	1670	2241	Slack	20.0	7.78	9.71
2	" "	"	1670	2046	"	12.9	8.88	10.14
3	" "	"	2087	1923	"	13.3	8.07	9.31
4	" "	"	175	232	"	19.0	9.75	12.
5	" "	Jones Underf'ed	100	216	"	14.6	9.07	10.62
6	" "	Hand Firing	100	193	"	13.7	6.71	7.78
7	Scotch	Jones Underf'ed	....	232	"	8.67	7.68	8.42
8	"	Hand Firing	....	170	Run of Mine	14.31	6.86	7.99
9	B. and W.	Chain Grate	600	852	Slack	13.1	10.08	11.60
10	" "	" "	100	115	"	19.4	6.39	7.94
11	Return Tub'lar	" "	125	179	"	17.5	10.35	12.56
12	" "	Hand Firing	125	134	Run of Mine	12.	7.8	8.76

76. If I have said little in this paper about means for smoke abatement other than stokers, it is because I believe that the stoker is the best remedy where it can be used, and that it should always be adopted in new power plants.

77. Whenever for any sufficient reason the stoker can not be introduced, there are other devices which will mitigate the smoke nuisance considerably and also save fuel. The steam and air blast has already been mentioned. A recent improvement which promises well is the combination of steam jets at the bridge wall with oil vapor, creating an intense heat at that point and consuming the hydrocarbons as they pass through. The expenditure of oil is comparatively small and considerable economy is said to result.

78. Brick arches and baffle walls have also assisted in maintaining a high temperature and in properly mixing the gases. The use of a reverberatory furnace or outside oven in which the coal and its gases are thoroughly burned before going to the boiler is another satisfactory method of reducing smoke, and may be used as well with as without a stoker.

79. In short, whatever produces good combustion abates smoke. In apartment houses and stores where the boilers are used for heating only and the steam pressure is low, the use of fuels which are comparatively smokeless is about the only satisfactory solution.

80. If the use of such fuels is supplemented by intelligent and careful firing, the results will be reasonably satisfactory.

81. Locomotive engines present an entirely new set of conditions requiring treatment radically different from that accorded to stationary plants. Several mechanical stokers have been designed for use on locomotives, and one of these at least has been fairly successful.

82. This application is still in the experimental stage, however, and it is to early to pronounce upon its future.

83. Most railroad companies have too rely entirely upon the skill of their firemen for abating the smoke nuisance within city limits and some of them have made a great improvement in this respect.

Regular and careful observations during the years 1900, 1901, on the railroads entering the city of Cleveland, showed a reduction in the average amount of smoke emitted by locomotives of from one-half to two-thirds, as a result of the so-called one-shovel system of firing, without any change in the furnace or equipment. The introduction of brick arches also proved to be a good investment.

I quote herewith the instructions issued by the management of one trunk line entering Cleveland, during the year 1900. These correspond in the main to a set of rules printed in the "Railway Age," in July, 1899, which were originally adopted by the C. & O. & T. R. R. as a means of reducing the fuel consumption.

Explanatory:

Bituminous coal contains a large percentage of hydrocarbons which are nearly all driven off as gas by the heat of the furnace in a few seconds after the coal enters the firebox. Hydrocarbons, when unconsumed, make objectionable black smoke, but when a sufficient quantity of air is mixed with the hydrocarbons, combustion is complete, and no smoke appears.

Rules:

84. After firing each shovelful of coal, the door must be left open one or two inches for a few seconds, admitting enough air to produce complete combustion of the gases driven off from the coal. Care must be taken not to leave the door open longer than necessary to consume the gases. Firemen must learn to work with as light a fire as possible.

85. Before starting, the blower must be put on and a sufficient supply of coal put in the firebox to insure a good, solid fire. After the coal has been put in the door must be left partly open, by placing the latch on the first notch of the catch, so to remain until the smoke entirely disappears, when the door must be closed.

86. The engineer should so arrange the water supply that the fireman may be able to fire the engine regularly and economically, and this can be done best when the water is supplied to the boiler continuously.

87. Firemen must pay particular attention to the manner in which the engineer works the injector and handles the engine, in order to regulate the fire accordingly. Care must be taken to have the blower applied and the door partly open when approaching a station at which a stop is to be made, and no smoke must be allowed to show from the stack at such times, or when descending grades.

88. While the blower is being used, except when approaching a station at which a stop is to be made, care should be taken to keep the door closed as much as possible, more especially when cleaning the fire, as the blower causes the cold air to be drawn into the flues. While lying on the side tracks, both dampers should be closed to save the fire.

89. Grates should be shaken only when absolutely necessary, as too frequent shaking causes a loss of fuel, by allowing the unconsumed coal to fall into the ash pan, where it ignites and causes the pan to heat and warp. Ash pans should be examined as frequently as stops will permit, and under no circumstances must they be allowed to become filled.

90. When possible to avoid it, fire-doors must not be left wide open. To leave the door wide open is especially bad when using steam or blower.

91. In closing I wish to call attention briefly to the legal aspect of the question, although this may not interest engineers as much as does the scientific aspect.

92. I believe that the municipalities have a right to insist upon the abatement of black smoke by all users of steam boilers, without regard to the purposes for which the steam is used or the means to be adopted for abatement. This, because smoke is a public nuisance and because it can be abated without hardship to the owner of the plant. Nevertheless, when the evil is present and has been present for a period of years, it is not good policy to be too radical in the enforcement of the statutes. The law should be definite and stringent and the penalties adequate, but they should be enforced with discretion by officials who have some technical and practical knowledge of smoke abatement.

93. It is absurd to talk of putting this matter into the hands of the police or of the health officer. The official having charge of this work should be a trained engineer, if possible a technically educated man, and he should be entirely above graft in any of its disguises.

94. Some years ago I was indicating to the municipal committee of a commercial club in a Western city qualifications for a smoke inspector somewhat similar to those just mentioned, when the secretary of the club, turning to his associates, remarked solemnly: "Gentlemen, I do not see but what we will be obliged to get an angel for this position."

95. As a rule, very little attention should be paid to complaints, since they are usually inspired by prejudice and neighborhood jealousy rather than by any knowledge of the actual conditions. The inspector should be in a position to know the condition and characteristics of each chimney, and these should be determined by systematic observations made by a trained assistant.

96. The observations should be made each five minutes and should cover all the time during which the chimney is visible.

To summarize the facts and principles of smoke abatement, I would repeat:

(1) Black smoke is a public nuisance and should be regulated by legal means.

(2) It is a result of imperfect combustion and can be largely abated by proper methods of stoking.

(3) Mechanical stokers offer the best means of accomplishing this result, in medium-sized or large plants.

(4) As smoke abatement is a result of better combustion, economy of fuel is the natural and obvious result.

To these I would like to add one more, a principle which is common to all reforms:

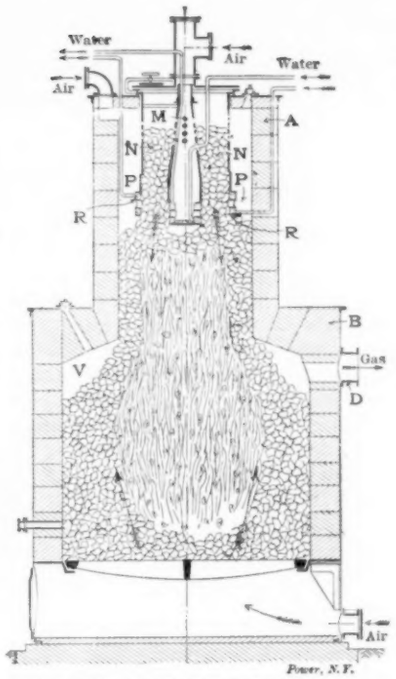
(5) An educated and intelligent public sentiment must be the moving and compelling force, without which mechanical devices and legal enactments will both fail.

When the public comes to realize its rights in this matter and that it is under no more obligation to submit to this nuisance than it is to endure bad drainage or filthy streets, laws will be enacted and enforced and the people will wonder that they so long submitted to this unreasonable imposition.

A French Design of Gas Producer.

This producer, the joint invention of A. Fichet and R. Henrtey, of 7, Rue de St. Petersburg, Paris, is shown in the accompanying cut. It comprises two gas producers superposed with separate air supply and a common gas outlet. The upper gas producer A has the draught reversed. The fuel is introduced at the upper part of this producer, and undergoes a partial combustion, especially as regards the hydrocarbons contained, which at the commencement distil off, and are then oxidized in the zone of the supply of air, and finally are reduced in the lower part of the gas producer in contact with the incandescent fuel. The base of this first gas producer is formed of an arch, which forms also the top of the lower gas producer. This arch is pierced at its center by an opening for the passage of the fuel into the lower producer B, where it finishes its combustion under the usual conditions. The form of the vault is arranged so as to create a vacant space V above the combustible. The gases produced escape at the surface of this space, and combine in the annular chamber thus formed, and from thence are conducted into the gas outlet D. The upper part of the top producer is arranged with a series of concentric chambers M N P, the walls of which are cooled at their base by the water pipes R. These chambers form alternating zones for the supply of the fuel and for the passage of the air for combustion.

The lower gas producer is fed continuously with the partially burnt fuel which descends from the upper producer. When the cinders are but little fusible, it is built like an ordinary gas producer, either with a revolving bottom or with a grating underneath for the admission of air. If



A FRENCH DESIGN OF GAS PRODUCER.

the cinders are very fusible, and have a tendency to agglomerate in large clinkers, they can be got rid of in the state of slag by adding, if needful, a little limestone or flux., In this case the bottom of the lower producer is constructed like a furnace with hearth, tapping hole, and tuyeres arranged in one or more rows. The gases produced in the hearth rise through the layer of incandescent carbon and combine under the arch with the gas arriving from the upper producer. The heat of the gases can be utilized for moistening and reheating the air for combustion either in an external tubular apparatus, or in an annular recuperator placed beneath the arch around the gas chamber. The apparatus can be arranged to work either by aspiration or by forced draught. —*The Mechanical Engineer.*

Turkish Patent Law.

We have long since given up surprise at the vagaries of Oriental legislation. That much-threatened potentate the Sultan of Turkey has lately afforded us an odd example of interference with those laws which affect, not only his own subjects, but those who do business within his realms. This time the Sultan's spasmodic activity has taken the direction of a revision of the taxes on patents and trade-marks. We could hardly object to the doubling of the taxes on future patents but when the proposal was to make this increase retrospective, then the Gilbertain absurdity of the edict became the most salient feature of the case, and would have so remained were it not for the widespread inconvenience it would cause under existing contracts and arrangements. Fortunately, the prompt action of the Embassies at Constantinople—whose attention was, we are informed by Messrs. W. P. Thompson and Co., of Liverpool, promptly directed to the matter by their agent—led to the revocation of this part of he decree. For some time past the whole subject of the patent laws seem to have exercised a fascinating influence over the mind of the Sultan, and one of his recent excursions was to declare that all proposed registrations of matters electrical were "contrary to law and order." Readers of this journal may fail to see this. In the case, however, of the prohibition of monopolies for photographic improvements, there is at least an underlying religious question involved, and we are sure that no foreigner would wish to interfere with the head of the Mohammedan faith in his interpretation of his belief. This is especially the case, as there has been great relaxation of the exercise of the law in this matter during late years. We are so often told of the magnificent manner in which foreigners manage their various Government departments, that it is a pleasure to think that in one direction Great Britain stands pre-eminent. We refer to the Patent-office. Here we have a department which steadily adapts itself to the requirements of the nation. By various stages the patenting of an invention has gradually been reduced in cost until now all but the poorest inventor is sure of protection for the offspring of his brain. This department has for its object the furthering of the industrial welfare of the country, and that is gained indirectly by the encouragement of the inventive faculties of our mechanics of every class.—*The Engineer.*

Recently Mr. W. H. Coleman read a paper before the Philadelphia Foundrymen's Association, in which he stated that very few modern foundrymen, even among users of positive blowers, care to utilize high pressures in the cupola for several reasons. (1) They find they can get their required capacities at the lower blast pressures; (2) the cupola lining will last longer under lower pressures; (3) oxidation of the silicon and manganese is greater under the high pressures, and this is only compensated by paying more for high silicon grades; (4) the resultant castings are smoother and easier to machine when made under the lower pressures; (5) there is less liability to slag under the the lower pressures; (6) greater strength in castings is obtained in melting by the lower pressures; (7) the horse-power required per ton melted is less at low pressures than at high pressures.

The best day's run made by the Cunarder Carmania on her first trip to America was 457 knots, and the poorest 305 knots. The exact time of the voyage was 7 days 9 hours 31 minutes. Heavy gales were experienced on three days.

CORRESPONDENCE

Discussing Phases of Machine Design and Construction

Making Press Tools for Medical Tablets

As I have not seen an article in the AMERICAN MACHINIST lately on the medical-tablet subject I am sending some sketches of tools used in this work that may interest some of those in the punch-and-die end of the business.

Where I was employed at one time making dies and punches, we had three makes of tablet presses, the Stokes, Mulford and the Richard multiple. It is of the latter make that I will write, as the dies and punches had to be about right on that machine. If they were not, it would be quickly detected in the tablets. We had to make the die as near perfect as possible, for there are six upper and six lower punches to one die, of the diameter and length given approximately at *A*, Fig. 1. The punches were made of Stubs' steel, in lengths long enough to make two. We centered them and then faced them so that we could grind the center off after they were turned to size. The center was on the head end; the diameter of the punch we left 0.0005 large, which we removed after the punches were hardened by putting them in the speed-lathe chuck and cutting off with emery cloth. The length of the head we faced to 0.249 inch, or 0.001 less than the head ring *B* of plunger chuck *C*, which is threaded to fit plunger end *D*. The body length we made the length of the punch holder or body ring *E*, and the length over all we left until we concaved the punches, when we made them all as near the same length as possible with a radius tool like the one in Fig. 2, after which they were hardened and drawn to a very light straw. Then we finished the length and polished the concaved end by grinding them on a hard-wood ball arbor, Fig. 3, the balls being made of a diameter to suit the radius of the concaved punch. A lot of care, and also patience was required for this as you might have five punches finished and then grind the sixth one short, then you would have to reduce the other five. The balls on an arbor like the one shown can be finished round and smooth by using the end of a tube, holding the tube against the ball and giving it a sweeping motion until the ball is the right radius.

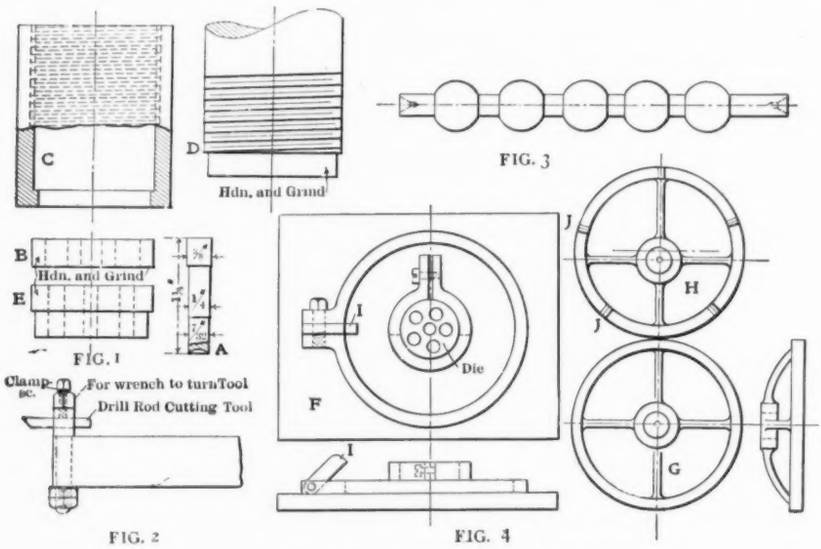


FIG. 1 FIG. 2 FIG. 3 FIG. 4

MAKING PRESS TOOLS FOR MEDICAL TABLETS.

The end of plunger *D*, Fig. 1, is made of tool steel, is faced square, and a thread cut to receive the nut *C*, which is bored to receive parts *B* and *E*; the smaller diameter of *E* must be a good fit. The head ring *B* is 0.250 thick, so that when the nut is tightened the head ring only is clamped, the punches being held snugly, but not clamped.

The head ring, body ring and dies are all drilled from the same jigs, shown in Fig. 4. *F* is the jig base made of a good grade of gray iron with a chamber bored in the center to a good fit for the die blanks which are round and 13/16 inch thick. The ring-like portion in which the blank fits is sawed free at the bottom for half the diameter, so as to clamp the work at the bottom as well as the top. The outer ring of the base is faced and turned a snug working fit for parts *G* and *H*, which contain the bushings for drilling and reaming. Jig *G* is for drilling the center hole of the die; jig *H* is for the holes off center, and is indexed by the hinged stop *I*, which fits in the peripheral slots *J*. Three hardened and ground bushings are used for each different size of hole, two for the drill and one for the finishing reamer, which must be kept in perfect order as a very smooth hole is required in the die for tablet work. After the die is hardened it is lapped smooth, after which it is ready for the press. It is first used for tablets that require close working dies and punches, but as it becomes larger from constant polishing, it is used for making tablets that require a free punch and die. There is another part to the die jig like *H*, which has three divisions for larger holes. This jig should be left free on the drill-press table and a very fine feed used.

C. W. SEILER.

Straightening a Large Shaft

I have read the article on the above subject at page 156 with much interest, and I do not doubt that E. Cooper Wills obtained the desired result by this method, but the cost must have been very great.

The method I should use, should I have a shaft to straighten, and I have straightened a good many in this way, would be as follows:

Heat the shaft at the bend to a nice red heat, and place between the lathe center, taking care that the outer curve of the bend is upward. Then play a jet of cold water on the top side until the shaft is straight. It is easy enough to ascertain when this result is obtained by the use of a scribing block. As soon as the shaft has pulled itself straight, start the lathe at a slow speed so that the shaft will balance itself, and continue to play a small jet of water all round the part where the bend was until it is quite cold, at the same time taking care to bring the tail-center in as the shaft contracts. The slower the shaft is cooled the better, and, if time is no object, it would do just as well to let the shaft cool naturally, and use no water.

This method is, I am sure, far cheaper than that described by Mr. Wills, as the lathe does not require any "rigging" at all, and no extra bolts, or rails, etc., are

required. All the necessary heating can be done on an ordinary portable smith's fire.

I may mention that I have straightened shafts up to 12 inches diameter by this method, and have never had the slightest bother in any way, and I have also found that the shafts have not been bruised or the finish damaged at all.

England. GEO. LETHERLAND.

Fixtures for Milling Nuts, etc.

The tools shown here have been in use for some time now and have given satisfaction, as they are easy to operate and produce accurate work.

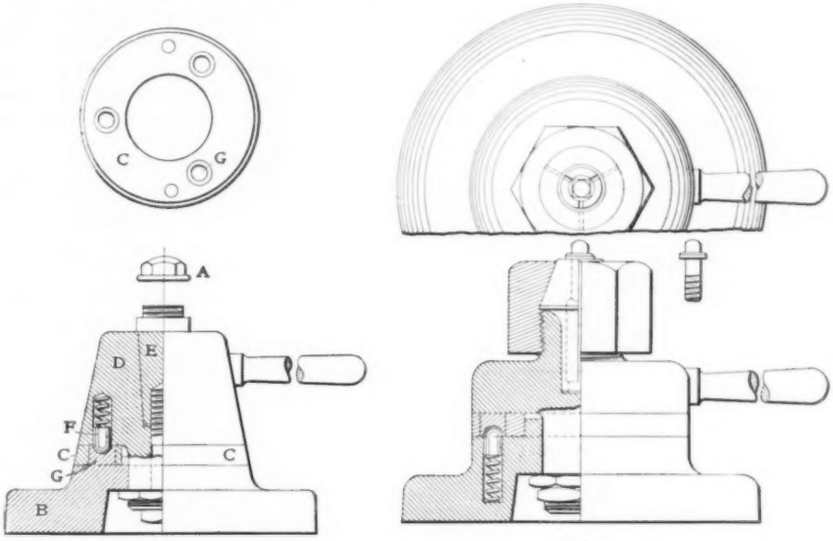


FIG. 1 FIG. 2

FIXTURES FOR MILLING NUTS AND SCREW HEADS.

Fig. 1 shows a fixture for milling hexagon nuts, such as shown at *A*. These are produced on the automatic from the bar and are then milled on the sides.

Referring to the sketch, *B* is the base of the fixture of gray iron; *C* is a ring of mild steel, carrying the bushings for the indexing; *D* is of mild steel carrying work arbor *E* and revolved by means of the handle shown at the right. It is held in position by the nut shown in the base of the fixture. *F* is the index pin whose lower end is spherical to fit in the bushings *G*, which are recessed to match. Behind it is a strong spring. The stud or arbor *E* on which the nuts to be milled are screwed has a taper shank and is held in position in the manner indicated. The index ring is doweled to the base. The bushings are a force fit and as straddle mills are used for the work, only three bushings are needed.

The stud *E* is readily removed and other studs inserted for other work. The index ring is also detachable so that any other number of flats may be milled by having the proper number of bushings. The operator has only one movement to make for each division. That is, one division having been milled, the work is rotated by means of the handle until the index pin springs into the next bushing. As only the proper number of bushings are in the ring the operator can make no mistake.

Fig. 2 illustrates a fixture for milling the squares on the heads of screws as shown. This tool is constructed on the same principle as the one in Fig. 1 as regards indexing, etc., the difference being in the manner of holding the work. The top part is of mild steel, bored to take a split chuck and threaded to take a clamping nut.

The index ring is provided in this case with two bushings, but may be changed for others for other divisions. The split chuck may also be changed to suit other work.

CYCLO.

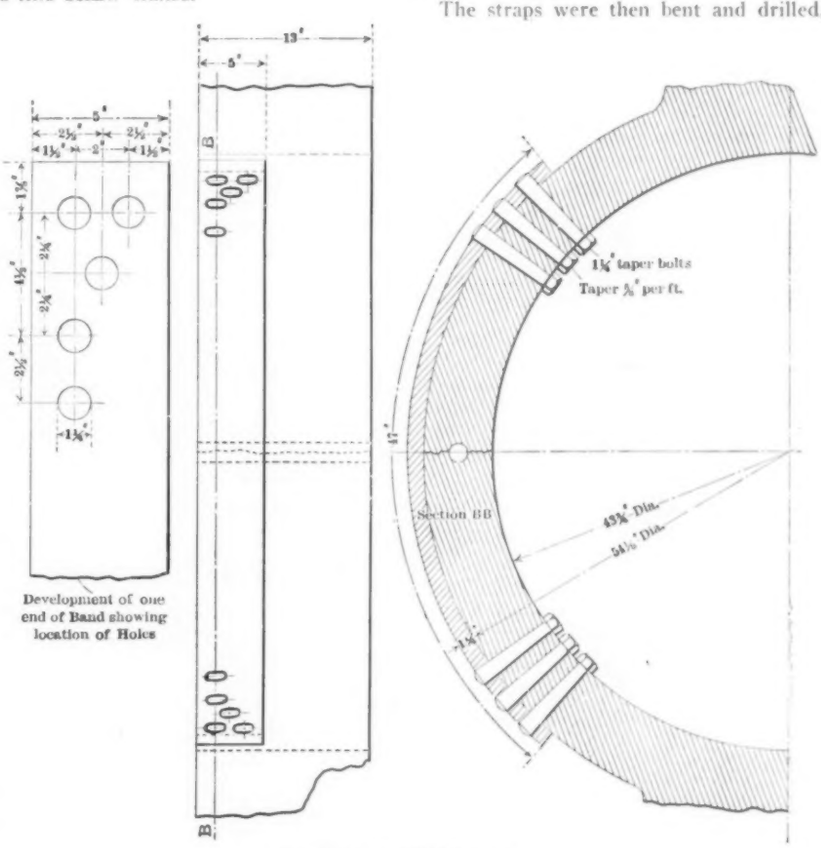
B——, England.

Repairing a Punch Press

Some time last year I was called upon to make a repair, which may be of interest to some of your readers. Before doing work of any importance I, like many other engineers, figure first and guess afterward. As the drawing shows, the repair was made on a punch-press table which had been broken in two in the center. To repair it I decided to put butt straps on the front and back of the frame.

I first assumed an initial tension of 36,000 pounds per square inch on the straps and then from the coefficients of elasticity and of expansion of steel I determined the elongation necessary to give this tension and the temperature to which the steel must be heated to give the elongation, finding 0.0351 inch and 100 degrees C. respectively. I next figured the strength of a drilled strap and made it substantially equal to the shearing strength of the taper pins. Following this I determined the comparative strength of the unbroken and repaired member considered as a beam supported at both ends and loaded at the center, and found the strength after repair to be 34 per cent. in excess of the original strength.

The straps were then bent and drilled,



REPAIRING A PUNCH PRESS.

while the parts of the press table, which were to come next to the straps, were properly dressed, after which center lines were scribed on the press and straps. The center lines on press and on straps coinciding, the strap was moved to the left 0.020 inch and one set of holes was scribed, when the strap was moved 0.020 inch to the right of the center line and the second set of holes was scribed. The holes were then drilled, the straps were put next to the press and the holes were taper reamed, when the straps were heated and put in place with taper bolts as shown. The repair has proven to be a good one, and it was done at comparatively little cost.

J. A. G. GOULET.

Turning and Boring Paper and Rubber

The mechanic who has never turned paper or rubber would undoubtedly think it a very simple affair to work these materials by the usual methods of turning and boring. A trial will quickly undeceive anyone.

My first experience was in turning paper frictions when an apprentice. These frictions were for elevators, and were 10 inches in diameter by 12 inches face. They were made from layers of ¼-inch thick brown paper, compressed by steel flanges, the bolts being drawn as tight as possible. The flanges were about ¼ inch less in diameter than the paper.

The job of turning looked like a "pipe;" but the way that paper rubbed the edge off the tool was a caution. We knew of no other way at the time, so the job was worried through with an abnormal amount of grinding of tools.

A short time ago in a job shop, a friction came in to be reduced one inch in diameter. I started in the usual way of turning things, but the foreman showed me the way to do the job. Fig. 1 is a sketch of the tool used.

The tool is made from ⅝ wide by ¼ thick cast steel, forged to a knife-like point, the side *A* being slightly rounded so as to rub on the paper, and prevent any cutting except at extreme point *B*. I soon found out that a cut less than 1/32-inch was not very satisfactory, and a cut 1/16 inch deep gave good results. For a finish cut take 1/32 inch deep, and have the tool as sharp as possible. A smooth stick used with plenty of leverage, will make the surface smooth. The paper all the time may be run at the fastest speed of the lathe.

After the experience with the paper frictions, a number of soft rubber pieces were to be cut up and made 2 inches long, and a ⅜-inch hole to be bored to 5/16. The hole was bored with the tool shown by Fig. 2, the 1/16 inch being taken out at one cut. The ends were faced with an ordinary side tool, ground to a knife-like point.

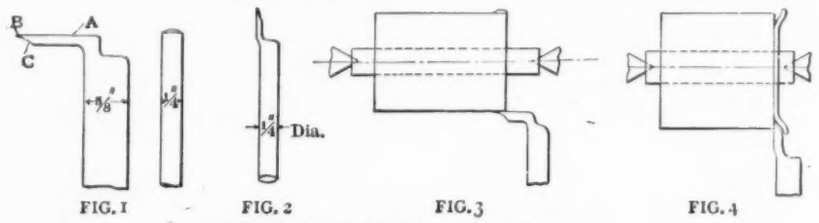


FIG. 1 FIG. 2 FIG. 3 FIG. 4

TURNING AND BORING PAPER AND RUBBER.

With the rubber, as with the paper, 1/32 inch is about the least that will give satisfactory results. The idea is to get under the material as in Fig. 3, so as to cut like a knife, the outside being kept free by the radius at Fig. 1. By this method the chips come off easily, looking like flakes of cut plug tobacco, and seem to cut as easily.

I have used these tools on paper and rubber only, but they will likely be useful on other material of a like nature.

WM. CLARK.

A Deep Facing Tool

The inclosed sketches show a tool that was made for facing valve seats in deep chambers on a pump. The seats, one of which is shown in Fig. 1, could not be removed without breaking them, and it was decided to face them off in place, which was successfully done with the tool shown in Fig. 3. The seats were already threaded in the center as shown and a bushing, Fig. 2, was made to screw into this hole, the bore of the bushing forming a bearing for the tit of the tool. The holder *B* was made of a piece of cold-rolled shafting with a shank turned on its upper end to fit the drill-press spindle and bored on the lower end to receive the pin *P*, a keyway *K* being cut as shown for the cutter *C*, which was also let into the collar *A* made of cold-rolled stock bored 0.01 inch larger than the holder *B*. With the cutter in place the wedge *W* was crowded in snug and the set screw *S* set up tight. This action brought the collar down firmly on the wedge and cutter, holding them firmly in place. The cutting end of the cutter was made curved as shown in the end view, in order that the cutting edge might come on the bridge walls of the seat with less abruptness and so prevent the steps that would be inevitable with a radial cutter. The pin *P* was made a separate piece instead of a part of the holder so that other sized pins and different cutters might be used for other jobs.

M. H. BALL.

Doing Worthless Work

I have read with interest all of the articles entitled "Doing Worthless Work to Order," and the various experiences, together with the different writers' comments, have been very instructive.

E. R. Douglass, at page 152, however, omits the qualifying words "to order," thus broadening the subject so as to include any worthless work. It seems to me that the points he brings out are very well taken and should interest everyone who is anyway connected with the management of a manufacturing establishment. The original topic affected directly only those shops which took in outside work; but as Mr. Douglass has put it, every factory is concerned, and I believe that to a greater or less extent signs of the worthless work, as he states it, will be evident in all, although the management is often ignorant of it. Probably the best regu-

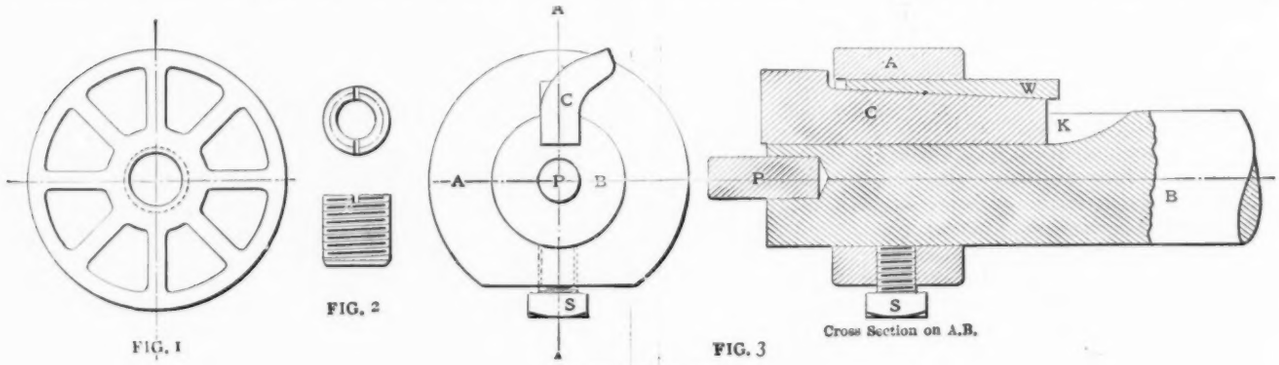


FIG. 1 FIG. 2 FIG. 3

A DEEP FACING TOOL.

lated system cannot overcome the fault entirely without red tape, which will prove more expensive than the "worthless work," which it is intended to eliminate. I use the phrase entirely in its literal sense, for, no doubt, the leaks pointed out can be partly overcome and conditions greatly bettered. His plan of overcoming the trouble appeals to us as good, and we have been impressed so favorably that we are going to give it a trial. We take pride in our shop system, because we consider it efficient and as simple as is consistent with the highest economy.

However, here is a point which we have overlooked entirely. Not that we were unaware that ideas, conceived by almost anyone in the shop, were worked up without authority; but we took it as a matter of course, and gave it very little thought. After the article referred to above, I made a round through the shop, with the purpose of noting the signs under the benches and in obscure corners of the "worthless work." The evidence was there—too much of it—and it is obvious that many needless trips have been made to the pattern and blacksmith shops to have unnecessary work done. Undoubtedly, there has been a leak in the business, of which we were unaware. As far as possible we will correct it, and believe that the cost department will show a tangible result of our efforts.

However, sometimes there is work done which has been authorized by the management, which would seem very useless to those who were not acquainted with the conditions which brought it about. This often causes adverse criticism, which is unjust. Two of the heaviest stockholders in our company once made a very thorough inspection of the shops, inquiring the reason and use of almost everything in sight. They had no knowledge of manufacturing conditions and knew nothing of the evolution of the machine, from its first primitive design to its present state. However, they were both capable business men, and understood very well the details and operation of the machine as it was then. All went well until they came to a pile of abandoned jigs and fixtures and when, after inquiry, they were given to understand that these were now useless, their disapproval was very evident. The pile certainly did look formidable, for it had grown large with the accumulation of years; and I imagine their estimate of the money spent on it was just so much dead loss in their minds. These jigs had been discarded through changes of design in the output or the conception of a much better fixture inspired by the use of the old one. This was carefully explained to our visitors, but evidently not to their satisfaction. They thought it displayed a lack of forethought not commendable. "Why didn't you put more thought on the original, and think of these better things in the first place?" It was not policy for us to reply, "Why didn't Fulton conceive the great ocean liners today, at first, instead of his little side-wheeler or Watt the powerful complex engines of the present time?" although the temptation to do so was very great. What their opinion would have been it is hard to imagine, had they known that draftsmen receiving high salaries sometimes work for weeks on a certain design only to have it discarded for something else. Or that certain parts of the machine had been finished complete more than once, going through all the departments to the finished product in the experimental room, only to be superseded by something better. In one instance a certain working part had passed the experimental stage and was adopted as a regular thing. The jigs and fixtures for it were ordered and nearly finished when we struck something very much superior, and the whole device, together with the jigs, tools and a lot of castings, was abandoned. This was apparently a waste of time and money, and seemed like useless work, yet we considered it valuable to us, for it was a necessary step to the better device, just as that which we are using now is likewise a step to the improvements which are sure to follow in the future. We made it as well as we knew how and gave it much forethought and study before it was considered ready for experiment. After something so much superior came up, it would have been folly to adopt the less desirable just because the jigs were made, for eventually the change to the better device would most certainly have been made. We consider the course we took economy rather than extravagance.

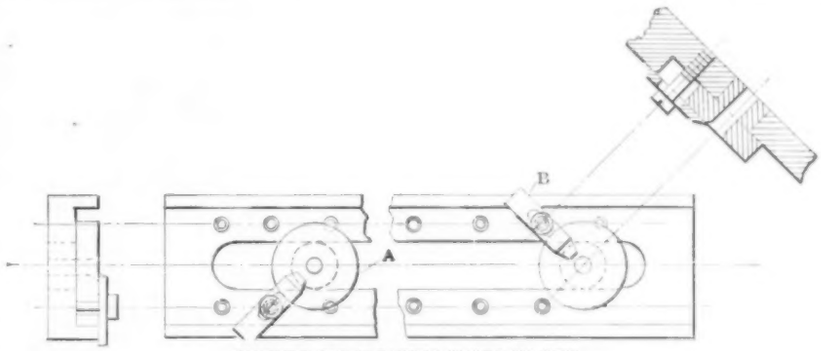
There is another class of work which, while by no means useless, is nevertheless false economy, and I notice that many still persist in it. It is the making of small screws, nuts, washers, etc., which can be purchased for much less than they can be made in small lots. Those who make the manufacture of these small supplies a specialty are so well equipped for making them that they can sell with a profit at a price much less than their cost to the average shop. This, of course, applies more particularly to standards rather than special work. The same is true of standard tools, as reamers, taps, etc. The tool-room must set up machines especially for the different operations on one or two tools, while the small-tool concern turns them out by the thousands at a time, and by reason of its special experience produces a superior tool. Inquiry of the concerns who specialize in small-tool supplies will often establish a policy of buying from them; and by so doing eliminate much needless expense incurred in attempting to make them in small lots.

We are very much interested in shop economy, and hope to read other articles in your columns which will show to our advantage other phases of the subject, pointing out useless or needlessly expensive work, as the article by Mr. Douglass has done. PESSIMIST.

Fixture for Locating Holes in Jigs

There are many jobs which have to be done in a hurry and at the same time accurately, and every machinist knows it is no snap to lay out holes and to bore or drill them and find when they are finished that they are within a half-thousandth.

This device is simple, yet accurate. You set the hardened bushings *A* by measuring across the outside with the micrometer and when right they are held in place by the little clamps *B*. The hole in each bushing is for a standard-size drill and the holes to be laid out can either be simply spotted or drilled down through as the case may require. The more bushings one has, the better. The sides of the frame for holding them, as well as the sides of the slot, are ground parallel, for in laying out a number of holes you work from a parallel placed to suit the position of the holes.



FIXTURE FOR LOCATING HOLES IN JIGS.

After you have one or more holes made, a pin is inserted in the bushing and passed through into the hole to be worked from and the other plugs set as before for the next hole. ARTEBE.

Packing a Gasolene-Engine Cylinder Head

Having a single-cylinder automobile, cylinder head not integral with the cylinder, I experienced a great amount of trouble with the packing. In one country run of forty miles I repacked the head five times. The water circulation was not good,

and consequently the great heat in the cylinder head would rupture the packing, and then the water would escape into the cylinder.

I tried the following methods of retaining the packing without success, using woven-wire asbestos packing in all instances:

1. I coated the packing, cylinder and cylinder-head faces with white lead, screwed up the studs as tight as possible, ran the engine until the head was warmed up, and re-tightened studs.

2. I used shellac instead of white lead.

At this point I was informed by an automobile expert that if I used silicate of soda to coat the packing my trouble would be over. I followed the advice, doing the work very carefully, and awaited results, which were a great improvement, as the job lasted one week.

I was nearly ready to sell out by this time; but as no offers occurred, I put in my time trying to find a remedy, and hit upon one which I tried as an experiment, and it has proven an entire success. Cylinder heads of this type have a boss that fits into the counterbore of the cylinder, which is not usually long enough nor fitted properly, and that is the primary cause of the trouble.

I took a piece of No. 16 gage annealed copper wire and made an endless ring by scarfing and soldering the ends together, the ring being just large enough to go over the boss on the cylinder head. I put my packing over the boss first, and then the copper ring, thereby having the thickness of the packing and ring at the joint of the cylinder and head. The main feature of this experiment was to select the right size of wire—a size that would exactly flatten and fill the joint and still leave pressure enough to hold the packing from leaking on the outside of the cylinder. I used the silicate of soda as a facing as before. I do not know whether this method is new or not, but I am sure it will be of great assistance to those who do not know of it.

F. C. MASON.

An engine bed weighing 105 tons was recently cast at the West Allis, Milwaukee, works of the Allis-Chalmers Company, this casting being the largest ever poured by the concern. It will comprise a portion of a 4000 horse-power tandem rolling-mill engine to be installed in the Edgar Thompson Works of the Carnegie Steel Company at Bessemer, Penn. The pattern for this casting measures 32 feet in length, 11 feet in width and 10 feet in hight, and represents the labor of ten patternmakers working steadily for over four months. The bed was poured from nine ladles, 108 tons of metal going into the rough casting. Fifteen days were allowed for the casting to cool before cleaning, and even after 20 days the heat still given off could be felt for a distance of several feet.

THE MANUFACTURE OF AN OPENING DIE

By Means of Various Labor-saving Devices

EDITORIAL CORRESPONDENCE.

The Ideal opening die illustrated at page 644, Vol. 26, is now made as represented in Figs. 1 and 2, one of the important modifications in its design consisting in giving the chasers increased support at side and rear, thus adding to their rigidity under the action of the cut. The sectional portion of the line drawing shows the internal mechanism of the present die, with the head of the removable shank at *a* and the ring for carrying the die body proper at *b*, the latter being clamped in position thru the medium of the nurled ring at the rear.

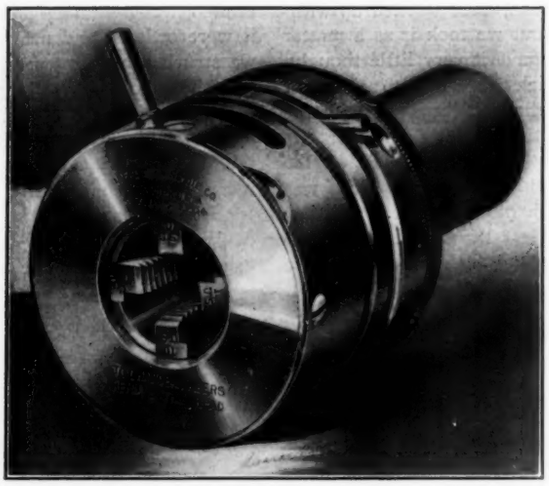


FIG. 1. THE IDEAL OPENING DIE.

The die head *c* is kept from turning, when in operation, by a pair of pins in disk *d*, which is held against rotation by pins *e*; and two springs on a pair of screws (one visible at *f*) hold *c* back in place until the turret slide is up against its stop, when the chaser-carrier *g* and head *c* are drawn forward until two driving pins *h* draw out of slot *i* at the end of the shank. Carrier *g* and chasers *j* can then rotate about cam *k* (which, as will be noticed, takes a bearing directly over the center of the chasers) and the chasers are thus drawn open, clearing the work instantly.

The shape of the cam *k* is indicated by the dotted lines in the plan view; and the method of adjusting this cam slightly to admit of roughing and finishing cuts being taken, and to regulate the size of the finished work, is shown at *l*. Eccentric pin *m* which engages with nut *n* carried by ring *o*, throws the cam to right or left when the handle *p* is operated, and screw *q* adjusts the nut to set the cam for the desired cut and thus determine the size of the threaded piece. The graduations on *o* (see Fig. 1) give the settings for right- and left-hand chasers, for threads of standard diameter, or for work larger or smaller than standard.

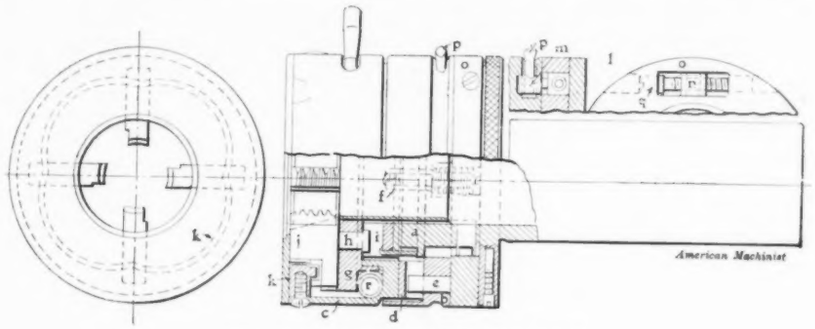


FIG. 2. SHOWING CONSTRUCTION OF DIE.

In closing the die, as the handle at the front is operated, the springs *f* draw the head back and, when driving pins and notches register, lock the chaser-carrier

fast against the action of spring *r* which throws the die open when the work is threaded to the required length.

Some of the appliances used in the manufacture of this tool at the shop of the Ideal Opening Die Company, West street, New York, are shown in Figs. 3 to 8, inclusive. Figs. 3 and 4 illustrate two groups of jigs and fixtures, most of which are shown a little more in detail in the sketches in Fig. 5. Thus *A*, Figs. 3 and 5, is a

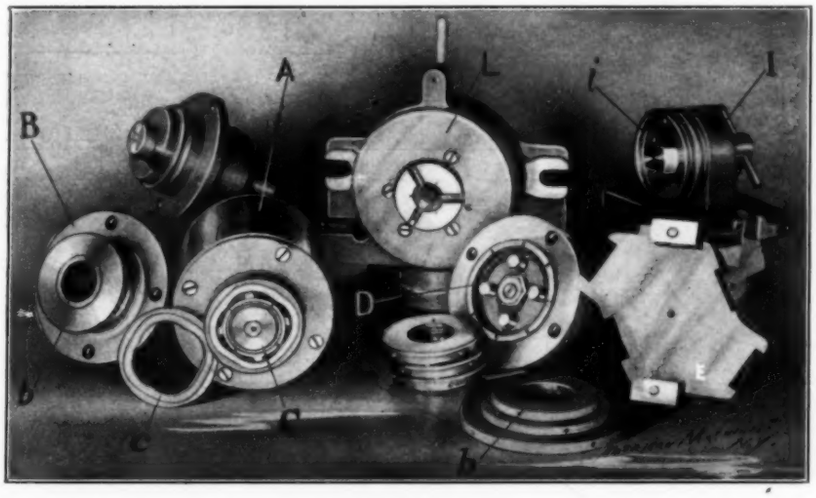


FIG. 3. OPENING-DIE TOOLS.

screw-machine appliance arranged, as brought out in the line engraving, to screw on the spindle nose and receive a number of chucks for holding different pieces employed in the construction of the die. A draw-in rod *a* operated by a hand-wheel at the rear end of the hollow spindle tightens the different chucks, these being carried by interchangeable holders easily attached to the body screwed on the spindle nose. Chuck *B* receives the adjusting ring *b* which, when finished, is placed at the rear of the die head. It is tapped in a previous operation and then run on the threaded drawing-in plug shown, which pulls it up tight against the chuck nose while it is being faced, turned and nurled. Chuck *C* for die cam *c* has four jaws confined by a spring wire and holding the blank from the inside. Like most of the other die parts, the cam is drop-forged, and the turning of the outside on this chuck is the first operation performed. After the cam has passed through several other operations and the plate at the front has been attached, it is placed in chuck *D*, where plate *d* is trued up and beveled at the outer edge and around the face of the opening at the center. The nurling tool shown at *E*, Fig. 3, is used in connection with chuck *B* for nurling three sizes of rings *b*, the supports for the nurls having three different positions about the holder to suit the diameters of the rings.

F, Figs. 4 and 5, is a jig for drilling ring *f* preliminary to broaching out the slot which receives the nut for adjusting the chaser cam. As will be noticed, this jig is used from both sides, the bushings being staggered, and very little stock is left to broach out after drilling. *G* is a drilling and tapping jig for the nurled ring *b*, and has a neat clamping device for the work, the piece being screwed freely on the plug at the front and the handle at the rear then drawing the work back tight against the finished seat.

The jig at *H* handles two different pieces, one of which is the shell *h* forming a part of the die casing. It should be noted that the clamp nut for the work not only secures the piece, but also releases it when turned back slightly. An open washer is used between the clamping portion of the nut and the work. The other piece handled in this jig is the cam *c*, which has four holes drilled and tapped in its periphery to receive screws passing through holes in shell *h*. When operating on this cam two sets of nurled and removable bushings are used, one size being suitable for drilling and the other for guiding the taps.

I, Figs. 3 and 5, is a milling machine fixture for holding ring *i* while the pocket indicated by the dotted line, is sunk in the periphery. The ring has already been drilled through the face and one of the holes is used as a locating point, it slipping over the projecting pin in the face of the fixture. When the handle at the rear is released the work may be slipped on or off over the head of the clamp bolt. *J*, Figs. 4 and 5, is a broaching fixture, used under an arbor press, for cutting keyways in different pieces, one of which is the ring *i*. The teeth of the broach are relieved on opposite corners, as indicated in the enlarged detail, thus breaking up the chip and allowing the tool to be forced through the work very easily. *K*, Fig. 5, is a small drill jig which clamps the cam *c* and its face-plate *d* together and holds them concentric while eight rivet holes are drilled through both members. The nurled screw passing through hole *h* and entering a tapped hole in the edge of the cam clamps the work to the top plate or nut and prevents it slipping while the latter is screwed down hard.

The fixture at *L*, Figs. 3 and 5, is an indexing affair for milling the slots in a die head *l* carrying three chasers. The work is located by its hub and held by a spring collet which is drawn down by a nut and screw at the bottom, the nut being turned by a wrench extending through an opening in the fixture base. With the device clamped in the position represented,

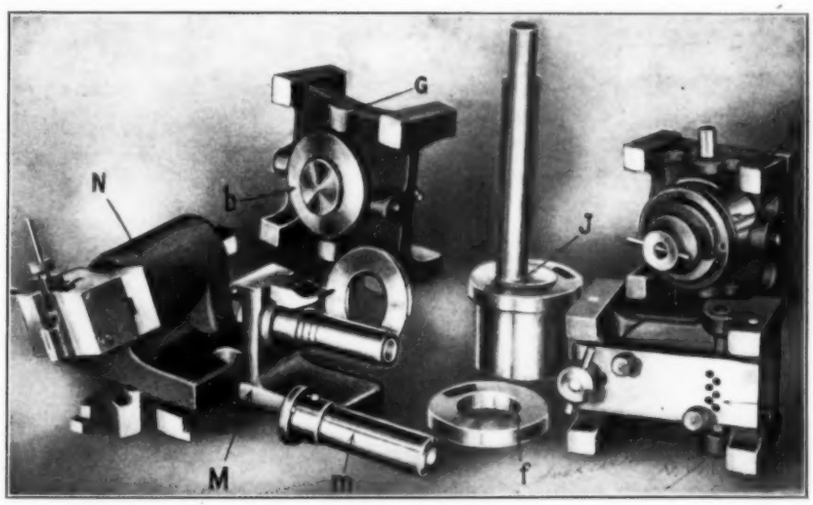


FIG. 4. OPENING-DIE TOOLS.

on the miller table, the three slots, one after another, are milled; with the fixture turned over on the other flat surface, three narrow slots, to receive guide keys for the chasers used in this particular die head, are milled at the side of the vertical slots, a T-slot cutter being used for this second operation.

The jig at *M*, Fig. 4, is a simple affair for drilling a hole in the side of the die shank *m*. This hole must be a certain distance from the head of the shank, so the pivoted piece carrying the drill bushing is formed with a notch whose shoulder is just the right distance from the locating boss in the jig when the leaf is dropped into working position. When the shank

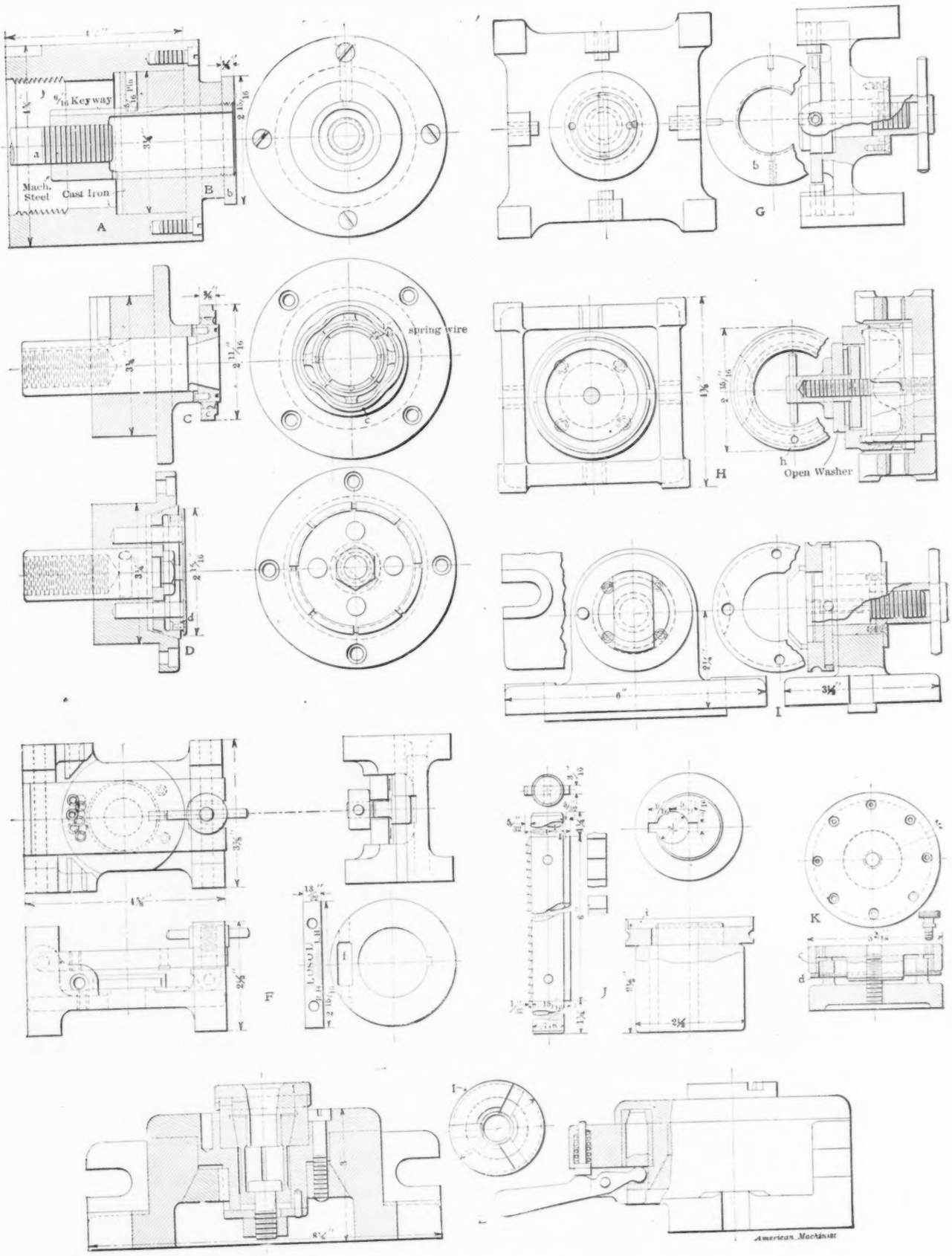


FIG. 5. OPENING-DIE TOOLS.

is slipped on the supporting stud the hinged piece is snapped down, and if the shank is not correctly located, or if the head is too thick the swinging member will not seat properly and the trouble will be located immediately.

N is a device for holding chaser blanks while the bearing surface for the cam is

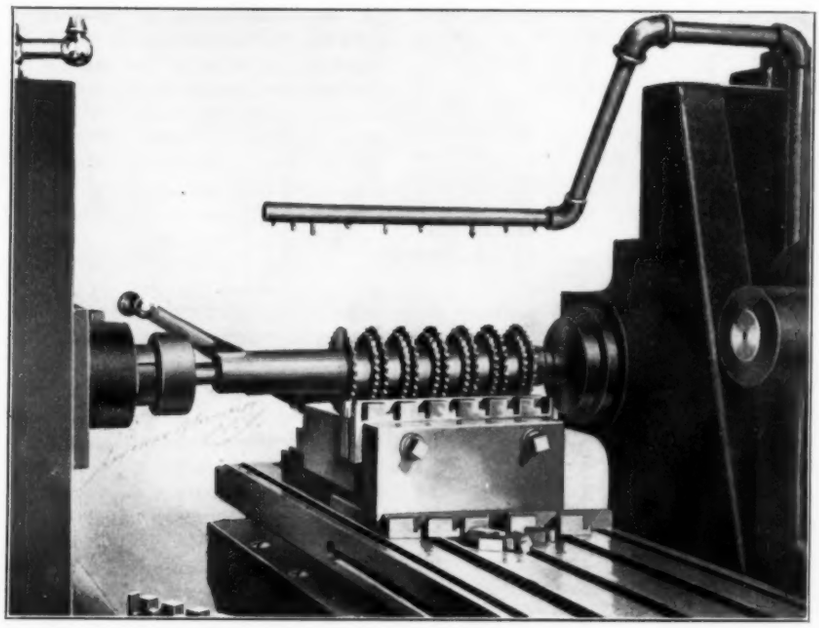


FIG. 6. CHASER-BLANK CUTTERS.

rounded off. This operation is performed in a miller, the blank being gripped in a pivoted vise which is rocked by the handle at the rear. The work is brought into contact with an end mill, then the lever is operated to swing the blank and carry the surface in question past the cutter, which mills it off to the required curvature. The vise is equipped with a stop which enables the blank to be located quickly and accurately.

Fig. 6 shows a gang of cutters used in a Lincoln miller for cutting off chaser blanks. These are really standard metal slitting saws and, with the exception of one end cutter, are grouped in sets of three, and not only cut the blanks to the required length but mill the notch under the chaser ear and reduce the ear to the correct length. Two pieces of stock of proper thickness, and each long enough for three blanks are placed end to end in the special vise jaws, the middle cutter of the gang being thick enough to dress off the inner ends of the two pieces properly. The cutters are of Novo steel; their teeth are slightly rounded off on alternate right and left hand corners, to break up the chip and so prevent the teeth wedging, and they last indefinitely.

The fixture in Fig. 7 is fitted to a Whitney hand miller and employed for profiling cams. A bracket is attached to the machine to carry the guide pin *A;* the form or master cam is mounted at *B;* the work is held in the chucks at *C*. The cutter will be noticed at *D*. The form is kept in contact with the guide pin by means of the table feeding and elevating handles. The guide pin and the master are slightly tapering, so that the mill may be allowed to wear within certain limits. By changing guide pins and cutters the attachment is made to take care of both inside and outside cam surfaces. A master cam and profiled piece are shown in the foreground, at *E* and *F* respectively.

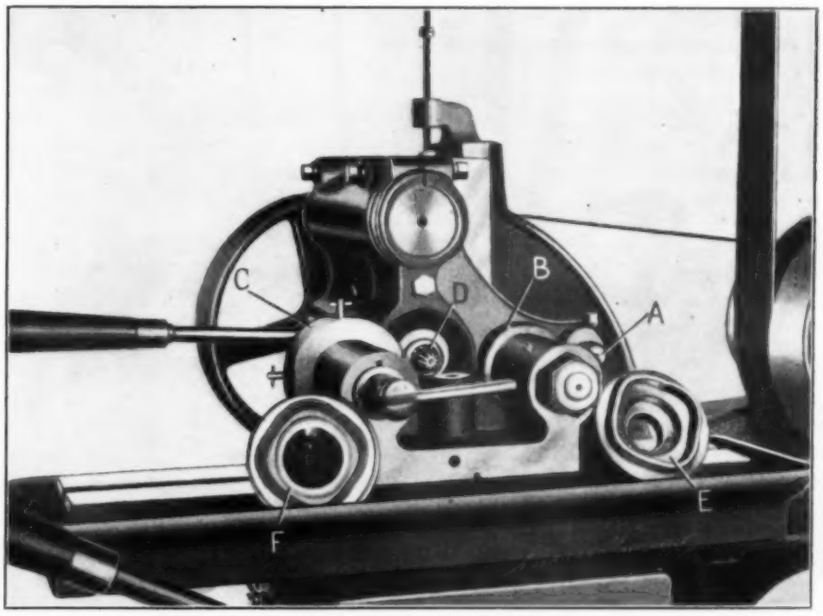


FIG. 7. CAM-PROFILING FIXTURE.

Figs. 8 and 9 represent a fixture used on a Cincinnati cutter and reamer grinder. This was designed for handling (after hardening) three-point cams, one of which may be seen at the front of the fixture. In order that the cam body may be true with the cam proper, the piece, when hardened, is gripped at the business end (on the three cam faces) by a three-jaw spring chuck and the bore ground out concentric with the cam. In another chuck carried by this same fixture the cam is held by the bore and the outside ground true. It will be seen from the drawing that the spindle of the attachment may be removed bodily from the casting with very little trouble; hence it is a simple matter to change from first to second operation spindles. While the work is being gripped by tightening the hand-wheel the spindle is kept from rotating by a plunger at the top, which is dropped into a seat in the spindle. This plunger when lifted and given a part of a turn remains clear of the spindle and allows it to be driven by the round belt and ground pulley.

F. A. S.

Liquid Air in England

Liquid air seems to have pretty much evaporated here but as has happened in the case of that arrant humbug Poleforcia, liquid air has, after evaporating here, gone abroad and it is being exploited, discussed and presumably invested in by London victims. In a recent number of *Engineering*, William Hampson, in commenting upon some claims made in behalf of liquid air as a source of power, or as a means of driving automobiles, says:

I will not ask to encumber your space with questions which only concern individuals and companies, for whom they will be decided by the law courts; but, on the practical side, it is desirable, as directly affecting the public interest, that any possible light should be thrown on the company's prospects of supplying on a business scale a material to be used as

a source of power for the propulsion of automobiles.

According to your account of the efficiency of the plant, it is of 250 horse-power, and capable of producing 700 gallons of liquid air per day. If its steam consumption can be kept down to 15 pounds per horse-power hour, and if it works for 10 hours a day, it uses $250 \times 15 \times 10 = 37{,}500$ pounds of steam daily in producing 700 gallons of liquid air.

Steam at atmospheric pressure has expanded to 1720 times the volume of the water from which it was made, whereas liquid air, in vaporizing to atmospheric air, expands only about 800 times. The densities of the liquids are approximately equal. Roughly, therefore, it may be said that liquid air, in vaporizing to atmospheric air, can develop only half as much power as the same weight of water vaporized into steam. Thus the daily output of 700 gallons—i.e., 7000 pounds—of liquid air is the power equivalent of 3500 pounds of steam, and for its production 37,500 pounds of steam are expended. So that, as a power-producer, the plant succeeds in converting 10.7 units of steam-power into 1 unit of liquid-air power.

As the usual factory expenses and profits must be allowed for, the purchaser of liquid air will have to pay much more than 10.7 times the cost of the same power from steam.

Accordingly, 5s. is the price asked for a gallon of liquid air, and a little consideration will show that this price fully meets the requirements. The gallon of liquid air weighs 10 pounds, and is equivalent in power to 5 pounds of steam, so that the price is 1s. for the power equivalent of 1 pound of steam. A pound of steam can be raised by one-tenth of a pound of coal, costing, say, the hundredth part of a penny. The drivers of automobiles, then, are invited to buy liquid air at a price which is 1200 times as great as that of a quantity of steam of equivalent power.

Remembering that liquid air is only half as powerful as steam, and that it is impossible to mount the most economical engines on automobiles, we see that each horse-power hour would want at least 30 pounds of liquid air. A 10 horse-power carriage, therefore, would require for a 10 hours' spin 3000 pounds of liquid air to drive the engine. But it is impossible to keep this material without a quantity constantly boiling away; so that it would be necessary to begin the run with a supply about half as great again as is theoretically required—say 4500 pounds—two tons of the motive liquid, at a cost of £112!

The tank to store this must have a capacity of 72 cubic feet; and as a thick insulation of at least 6 inches would be required to check the boiling off as much as possible, the external dimensions of the tank to be mounted on the automobile would be 7 feet by 5 feet by 4 feet. Perhaps, however, the design provides for putting it on a tender coupled on behind.

It is remarkable what optimism has characterized the proceedings of liquid-air companies in the past, and enabled them to build and maintain the highest hopes on an unbroken succession of disappointments and mistakes.

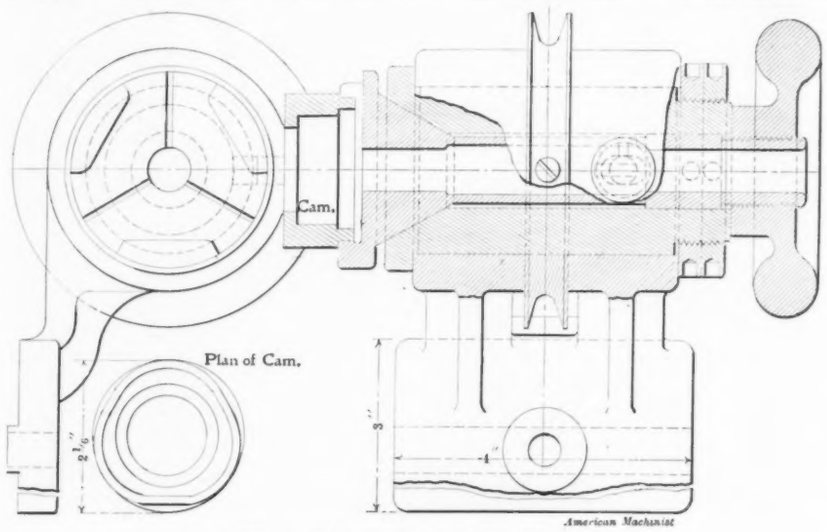


FIG. 9. CAM-GRINDING ATTACHMENT.

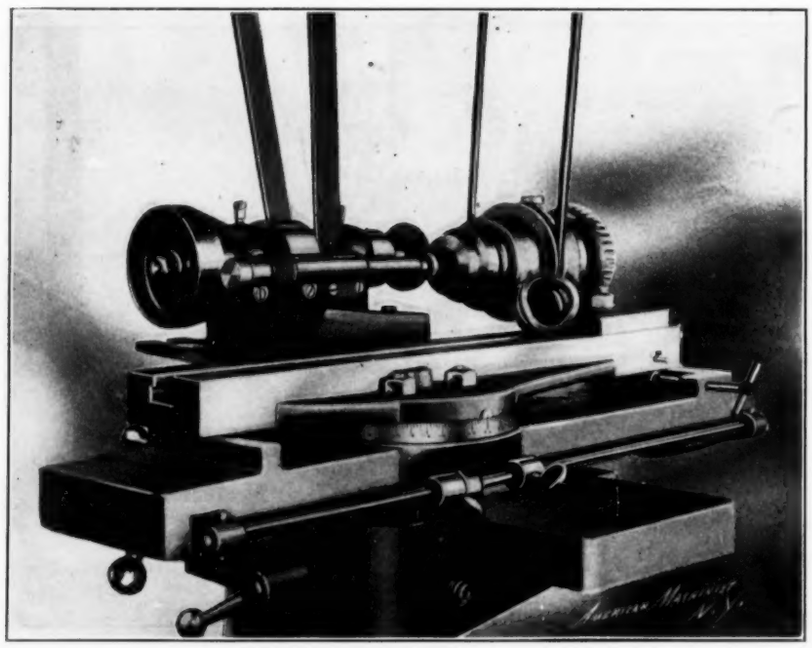


FIG. 8. CAM-GRINDING ATTACHMENT.

In the early days of popular excitement over liquid air, I was approached by a number of company-promoting syndicates who wished to use my name in the flotation of liquid-air companies, hinting, in reply to my objection that the material was far too costly for practical use as a source of power, that the essentially important fact was that the public were then in the humor to bite, and that promoters could get rid of their holdings before the crash came.

In America a number of companies were at that time formed, the Tripler Liquid-Air Company, the General Liquid-Air Company, and others; among them the Liquid-Air Power and Automobile Company, Limited, of Boston. I have a copy of the latter company's prospectus, which stated, six years ago, that liquid air, as applied by its inventors, "would eclipse steam, electricity, and all other motive powers." "Railroads and street railways will certainly adopt liquid air as used by our methods." "The first of the automobile wagons will be completed and ready for delivery about July 1, 1900." "The cost of manufacture is trifling." "The surgeon's knife will be largely supplanted by liquid air." "This enormous power will in a few years, if not months (of July, 1900), supersede in many ways steam, electricity, compressed air, gasolene, and all other powers now in use." "Holding

the patents on these inventions, we hold the key to millions in profits," and so on for sixteen pages.

Those who think of taking an interest in liquid air power and automobile companies will like to study the description of an automobile vaunted in the above prospectus, by way of seeing what kind of engineering has been put into the invention of liquid-air automobiles.

The automobile in question is described in the prospectus as being driven by liquid air, which is vaporized, not, as it should be, by the heat of the surrounding atmosphere, but by electricity-heat generated by a dynamo driven from a pulley on the main axle of the carriage! This is as if the heat to boil the water in a locomotive were obtained from electricity generated by a dynamo driven from a pulley on the main axle of the engine. It is an unmitigated case of perpetual motion. The illustration, as well as the description, show that the whole expansive force of the air is obtained from the electricity-heat; though, even if it were intended to be used only for reheating effect, it would still be absurd to get any part of the energy to move the carriage out of the energy with which the carriage moves.

The system would, of course, if it worked at all, work as well with liquid ammonia, carbonic acid, or water, as with liquid air.

Circulars issued with copies of the above prospectus contain some more stimulating matter. "As a power it is one hundred times more powerful than steam." Why then did the accompanying prospectus say that "1 cubic foot of liquid air will develop 5½ horse-power?" A cubic foot of liquid air weighs about 60 pounds, and 60 pounds of steam can be made, in the very best engines, to develop about 5½ horse-power for one hour. As a fact, liquid air, instead of being, as in the circular, 100 times, is really only half as powerful as steam.

"The company proposes to manufacture, sell, and deliver liquid air for refrigerating purposes at a very nominal cost, much below that now expended for ice, yet admitting of a large profit to the company." This will not be possible for any company which has to sell liquid air at 5s. per gallon of 10 pounds; 5s. will pay on a commercial scale for 5 hundredweight of ice, with a refrigerating power more than 50 times that of the gallon of liquid air.

Such having been the methods of the liquid-air companies of the past, we shall expect any which are to live and thrive in this country to deal in much smaller promises and much larger achievements.

The National Civic Federation announces that it is expected its special committee, appointed and sent to Europe to study the matter of public ownership and operation of public utilities, will be ready to render a full report in December.

Foreign Markets for American Goods in Bolivia and Russia —Competitors Alert— Personal Equation in Russian Deals

One of the principal difficulties connected with the mining industry on the Bolivian tableland is the want of cheap motive power. In many parts of Bolivia permanent water power is not generally available to any extent; coal is too expensive and the native fuels are getting scarce. A solution appears to have been found that may very likely surmount all difficulties of this kind; it lies in the use of anthracite gas engines. Makers of this description of gas plant should give attention to the effect of altitude on the efficiency of gas engines for countries possessing the peculiarities of Bolivia, where work is carried on at an altitude of from 12,000 to 14,000 feet. As an example it may be stated that the gas engines in use at the town of Oruro give about a 70 per cent. efficiency, using about 1.5 lb. of anthracite per horse-power hour. These particulars refer to plants near the Antofagasta railroad. For mines at a distance the added cost of transporting the anthracite largely increases the cost. Hence the possibility of reducing the fuel consumption, even by a fractional amount, is of supreme importance. There is every probability that in the next few years many more and larger plants of this sort will be erected and the consumption should not exceed 1¼ lb. per horse-power hour.

With reference to electric power, on the eastern and northeastern flanks of the great Bolivian tableland the rivers that form the head waters of the Amazon and River Plate systems offer great possibilities for the generation and transmission of this power. To be of service in the principal mining centers this would mean transmission over a distance ranging from 50 to 120 miles. Great interest has been displayed in this question of electric transmission, and surveys have already been made. It is known from the result of one survey that many thousands of horse-power are available and that for mines in certain districts the cost would be much less than that of the power at present in use. One company has already a hydro-electric transmission of 2000 horse-power over 78 kilometers. Foreign engineering firms are beginning to be interested in the market for hydro-electric plant that is growing up there. This matter can be dealt with only by competent technical representatives who can supply approximate estimates and all necessary information, and also visit the country itself. Apart from this class of machinery, the principal things of interest to the Oruro importers are various descriptions of gas producers, oil motors, machines for the magnetic separation of ores, rock-boring machines, electric machinery for power transmission and lighting, electric mine hoists and ore-concentrating machines.

There is a very good demand for machine tools in Russia. Most of the better class tools are imported, Germany being the principal supplier, although British goods are pretty strongly in evidence in the stores, etc. The chief objection to the British manufactures is their relatively high price, but their excellence is admitted. All tools and machines supplied to the Russian market should be rather more strongly made than if intended for home use, as the Russian artisan is usually not so skilled and is somewhat rougher in his methods than his more educated British or American confrere. The Russian Empire is such a gigantic institution that the record of riots, murders, and rebellions that reaches the outside world from time to time really affects only a part of the country and generally only a small portion of it. The present disorder in some Russian towns should not prevent American manufacturers from fostering the market. It should be remembered that, owing to the disintegration of the railroad system, the supplies of machinery, etc., in many districts must have run short and must be made good in order to keep works running. If American firms don't look after the business there are plenty of foreign competitors who have a better grasp of the situation. In Siberia there is plenty of money, due to the excellent harvests and to the large payments made for the provisioning, etc., of the Manchurian army.

It is very desirable that the heads of large firms dealing with Russia should visit that country from time to time to see how matters stand, and what is quite as important, to be seen by the chief of the Russian firms. When a subordinate visits as a representative he is seen by a subordinate, whereas when a principal visits he is seen by a principal. Many heads of Russian houses understand English quite well, and nearly all of them speak French or German. In Russia individuality, that is, knowing personally the individual with whom you are transacting business, goes a long way. It is quite an important factor and must be taken into account. Good Russian firms perfectly well understand that for a first-class article they must pay a correspondingly good price, and they are willing to do so, provided they are allowed a fair amount of time.

Most Russian firms are not overburdened with capital. Such firms are quite reliable, and although they may be doing a large business, cannot pay out cash until part, at all events, of the consignment received is sold, and, more important still, is paid for, for often virtually the whole of the capital of the firm is represented by their goods. Such firms cannot pay cash

down, and if they cannot get credit from American houses they have to go elsewhere. In years gone by a year's credit was generally allowed; today it runs from 6 months upward, varying considerably with the class of firm dealt with and the description of goods supplied. If you cannot get thoroughly competent Russian translators for catalog work the next best language is German, which is quite well understood in all commercial and industrial Russian centers. The German "mark" is readily converted into the Russian "ruble," and all Russian firms understand the metric system. With Moscow houses dealing in machinery, German is a current trade medium. The use of German is infinitely to be preferred to English when dealing with Russians.

London, England. F. C. C.

The Force of a Blow

BY D. B. DIXON.

A falling body cannot do more work when its progress is arrested than has been done on it in lifting it to the hight from which it has fallen. For example, let us suppose that the monkey of a pile driver weighs one ton, and that it falls four feet onto the head of a pile; then, the work in the monkey cannot be either more or less than four foot-tons.

The work in the monkey at the moment it touched the head of the pile would be sufficient to raise the monkey again to the point from which it fell; or to raise a weight of four tons a hight of one foot; or to raise one pound through a hight of $2000 \times 4 = 8000$ feet; or to raise a weight of 48 tons through a hight of one inch, and so on. It is essential that this little matter of equivalence be clearly understood. We may go on ringing the changes how we please between weight and hight, the result will invariably be the same; one element in the calculation being always diminished as the other is increased. Now, it is clear that if the monkey were employed to raise one ton through a hight of four feet it must exert a force or push of one ton throughout the distance of four feet. If it did not, it would not move one ton at all, for it would be overbalanced. If it were called upon to raise four tons through a hight of one foot, then it must exert a push of four tons through a distance of one foot; if to lift a weight of 48 tons, then it must exert a push of 48 tons through a distance of one inch, and so on. Bearing this in mind, there will be no difficulty in understanding the following simple rule:

The force of a blow is measured by dividing the whole distance passed through by the monkey before impact by the distance passed through after impact, and multiplying the weight by the quotient.

Thus, let the monkey weigh one ton, let the fall be 48 inches, let the pile descend one inch at each blow, then the force of the blow—or in other words the push or effort exerted by the monkey on top of the pile—will be 48 divided by 1 equals 48, and 48 multiplied by 1 equals 48 tons. If the fall was 20 feet or 240 inches, then the effort would be 240 tons and so on.

It must be understood that this is the mean or average force of the blow. Its initial effort may be much greater, and its terminal effort may be much less, because at the instant of impact the monkey is moving at its full velocity, while at the moment when the pile ceases to descend it will have no motion at all, and consequently will exert no push, except that due to its weight.

It will be seen that the force can be varied by altering either the distance passed through before or after impact. For example, the monkey weighing one ton and falling 48 inches, let the pile descend only $\frac{1}{8}$ inch, then $48 \times 8 = 384$ tons and this leads to an important deduction. If the distance moved through becomes infinitely small, the force of impact will become infinitely great. We are led thus to the ancient problem, "if an irresistible force encounters an insurmountable obstacle, what will happen?" No such condition can by any possibility occur. Some movement must take place after impact. Three factors are in all cases necessary, namely, the weight, the hight of fall, and the distance through which the body which receives the blow moves. In practice it is by no means easy to ascertain the latter with precision; and the energy in the falling body can be expended in more ways than one. For example, when the head of a pile is struck two effects take place simultaneously—the monkey is shortened and so is the pile. Again, the top of the pile becomes highly heated. In very dry weather the top of a pile has been known to take fire under the blows of a light monkey rapidly repeated. The elasticity of the pile plays an important part in influencing the rate of its descent, or its penetration into the ground. A monkey weighing 100 pounds, and falling from a hight of 50 feet, will have stored in it on impact $100 \times 50 = 5000$ foot pounds, and if the progress of the pile were one inch, its driving force would be $600 \times 100 = 60{,}000$ pounds. A monkey weighing 1000 pounds and falling 5 feet, would also have 5000 foot pounds of work in it, and would exert a driving force of 60,000 pounds over a space of one inch; but it does not follow that the former would be equally effective in driving the pile. On the contrary, the lighter monkey striking the pile with a higher velocity might be much the less efficient of the two, because the force of the blow would not be transmitted through the pile, but would be expended in compressing the top of it, probably in shattering the wood. When a pile is struck on the top, what is known as a wave of compression passes through it; and this wave requires time for its passage. Such a wave is set up in all columns when stress is suddenly brought on one end. Thus, for example, if the muzzle of a shot gun containing a column of air is plugged up with a cork, or with snow or mud, the barrel may be burst when the weapon is fired, simply because, while the pressure at the muzzle is yet too small to move the cork, the pressure at the breech end is great enough to burst the barrel. The wave of compression will not reach the muzzle till the breech has been burst. In the same way the detonation of a stick of dynamite on a rail will break it, the action being so sudden that the wave of transmission of pressure has not time to pass through the air surrounding the dynamite, and the air really plays almost the same part as a block of steel round the explosive. The effect of a heavy ram falling a short distance on a pile head resembles a push, in a sense, and gives time for the transmission of the effort throughout the whole pile; but when a light monkey falls, the effect may be confined to the top of the pile, which is shattered. In order to make this quite clear, we must take into account the element of time, concerning which we have said nothing yet. The velocity with which a monkey strikes a pile is calculated by extracting the square root of the hight of fall in feet and multiplying it by eight. Thus, let the monkey fall four feet; the square root of 4 is 2, and 2×8 equals 16 feet per second. If the monkey falls, as stated in our last example, 50 feet, then we have 7 as the nearest whole number square root, and 7×8 equals 56 feet per second as the velocity with which the monkey would strike the pile. If this speed was greater than that at which the wave of transmission could pass through the pile, then little or no effect would be produced in the way of causing its descent; nearly the whole of the work would be done in compressing the top of the pile or in shattering it, and the driving effect would be nothing. The effect of the element time is not sufficiently well understood. About, indeed, the only thing fully recognized is that a heavy monkey falling from a moderate hight is, other things being equal, much more efficient than a light monkey falling from a great hight.—*Power.*

Melting points of various metals:

Tin	449°F.
Lead	620°F.
Zinc	786°F.
Antimony	1169°F.
Aluminum	1214°F.
Silver	1751°F.
Copper	1943°F.
Gold	1947°F.
Nickel	2600°F.
Pure Iron	2737°F.
Platinum	3110°F.

THE EXPERIMENTAL SHIP TANK OF THE UNIVERSITY OF MICHIGAN

Object to Determine Resistance to Motion of Various Forms of Ships — How Experiments are Conducted and Drawings and Models Prepared—Calculation of the Resistance of a Full-sized Ship

BY HERBERT C. SADLER*

As the experimental tank and apparatus connected therewith is now completed, a short account of the method of preparation and testing of ship models may be of interest at this time.

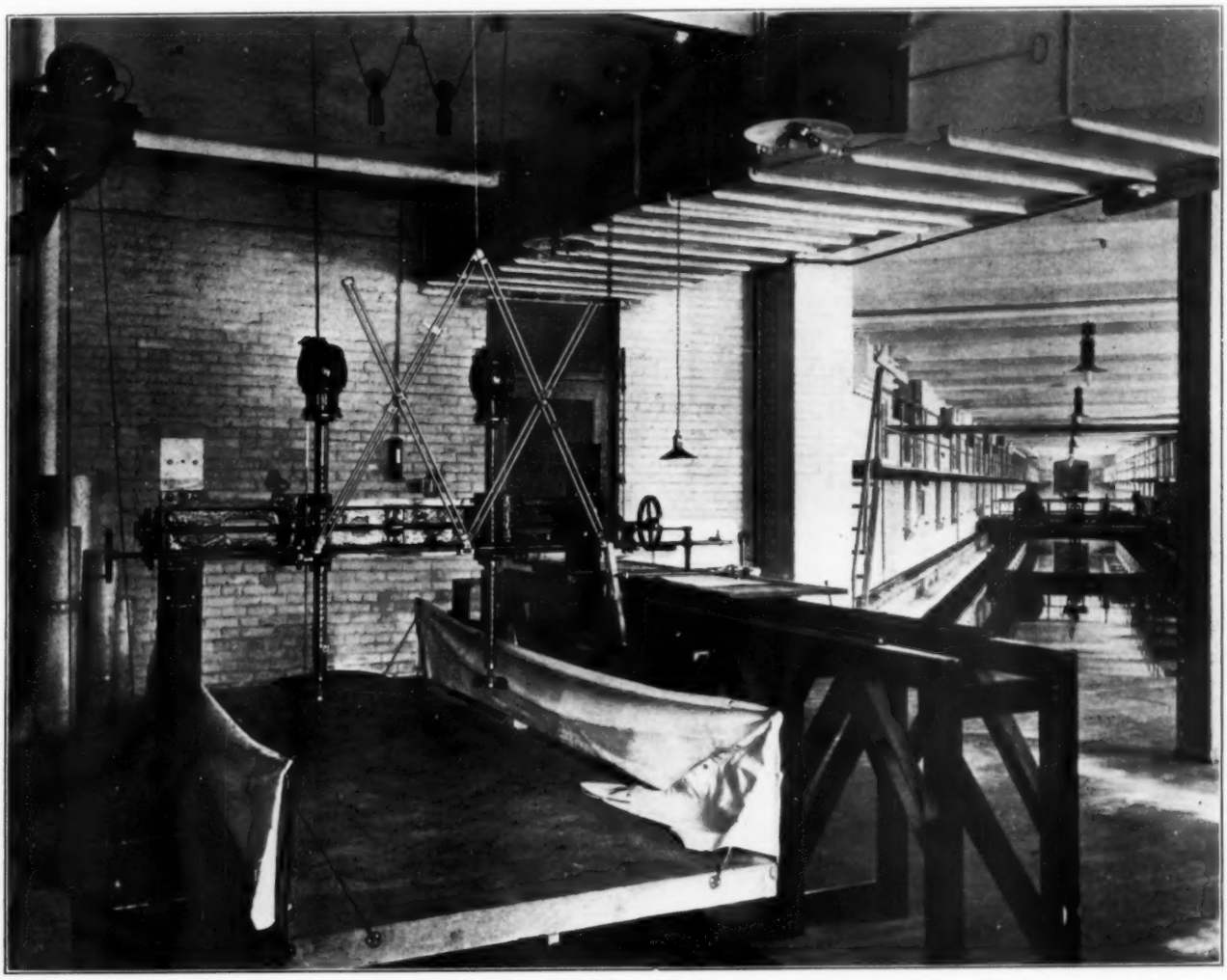


FIG. 1. MODEL CUTTING MACHINE. TANK IN BACKGROUND.

THE OBJECT OF THE TANK.

In the first place it may be pertinent to describe in a general way the object of the tank. The shape or lines of a vessel, together with the estimate of the horse-power necessary to drive her any given speed, is the most interesting and at the same time most difficult part of the naval architect's work. Fortunately or unfortunately the nature of the conditions to be fulfilled is rarely the same for any two ships, so that although former experience, properly and scientifically applied, may be of great value in solving any new problem in ship propulsion that may arise, it seldom happens that a new design is the exact counterpart of a former one. It is, therefore, difficult to say beforehand what the effect of modifications of a vessel's form will be, and even more difficult to say which is the best form to fulfil any given set of conditions.

The primary object of the tank is to perform experiments upon various forms of ships and to determine the resistance to motion of these forms at all speeds. In general the line of work that will be followed will be of a systematic character, that is to say, models of various forms will be tried and the effect upon the resistance of modification of these forms, such as variations of the ratios of length to beam or draft, determined. Numerous other experiments such as the effect of bilge keels upon the rolling and speed of vessels will also receive attention.

HOW EXPERIMENTS ARE CONDUCTED.

The tank itself is 300 feet long, 22 feet wide, and 10 feet deep, and forms the basement to the east wing of the new engineering building. This length is the least that can be used in order to allow time for starting, obtaining uniform speed and stopping. The breadth and depth are necessary so that the effect of the sides and bottom will not have any material influence upon the resistance of the model. Spanning the tank is a traveling truck which runs on rails on either side of the tank. This truck, shown in Fig. 2, is driven by a 25-horse-power motor whose speed can be so regulated as to give speeds to the truck varying about 10 feet per minute up to 800 feet per minute. It is essential that the speed of the truck

*From the *Michigan Technic*.

should be uniform at any speed between these limits, so that the resistance of the model may be determined accurately at any speed. The models are run at a series of different speeds and a curve of resistance in terms of speed obtained. In order that the speed may be uniform and not affected by changes of load in the power house, a special motor generator set has been installed, and owing to exigencies of space and also for convenience, has been placed upon the truck. The current from the power house is taken to this set by trolleys and converted as required. The connections are such that if any fluctuation takes place upon the line, this is compensated for in the installation and the speed of the driving motor remains unaffected. The speed is regulated by a controller with five main stops, and between each stop an auxiliary rheostat with fifty stops may be thrown in, so that between the limits of speed given above, two hundred and fifty different speeds may be obtained. The driving motor is also fitted with a high- and low-speed gear. The switchboard and connections are also mounted on the truck.

On the forward end of the truck is the dynamometer through which the models are towed. This consists essentially of a vertical bar mounted on Emery supports, that is to say, instead of the usual knife edge a thin piece of spring steel is used, with about 1/16 inch between the supports. This gives a rigid but flexible and practically frictionless bearing. Parallel rods are introduced so that both the pull upon the spring and model are in a horizontal direction. The model is attached to the lower end of the dynamometer and its resistance taken up by the spring as shown in Fig. 3. The amount of extension of the spring is registered upon a revolving drum which is driven from the main shaft of the truck. Upon this drum are two other pens, one of which is connected to a clock and registers every half second, the other is connected with contacts along the side of the tank and registers every 10 feet. Thus the time and distance and hence speed are determined. Two other pens register the amount that the model rises or falls at the bow or stern, when moving at different speeds. While not at present installed, a camera will also be arranged so that a photograph of the wave formation may be obtained. The above are the principal observations that are taken in connection with the truck and dynamometer.

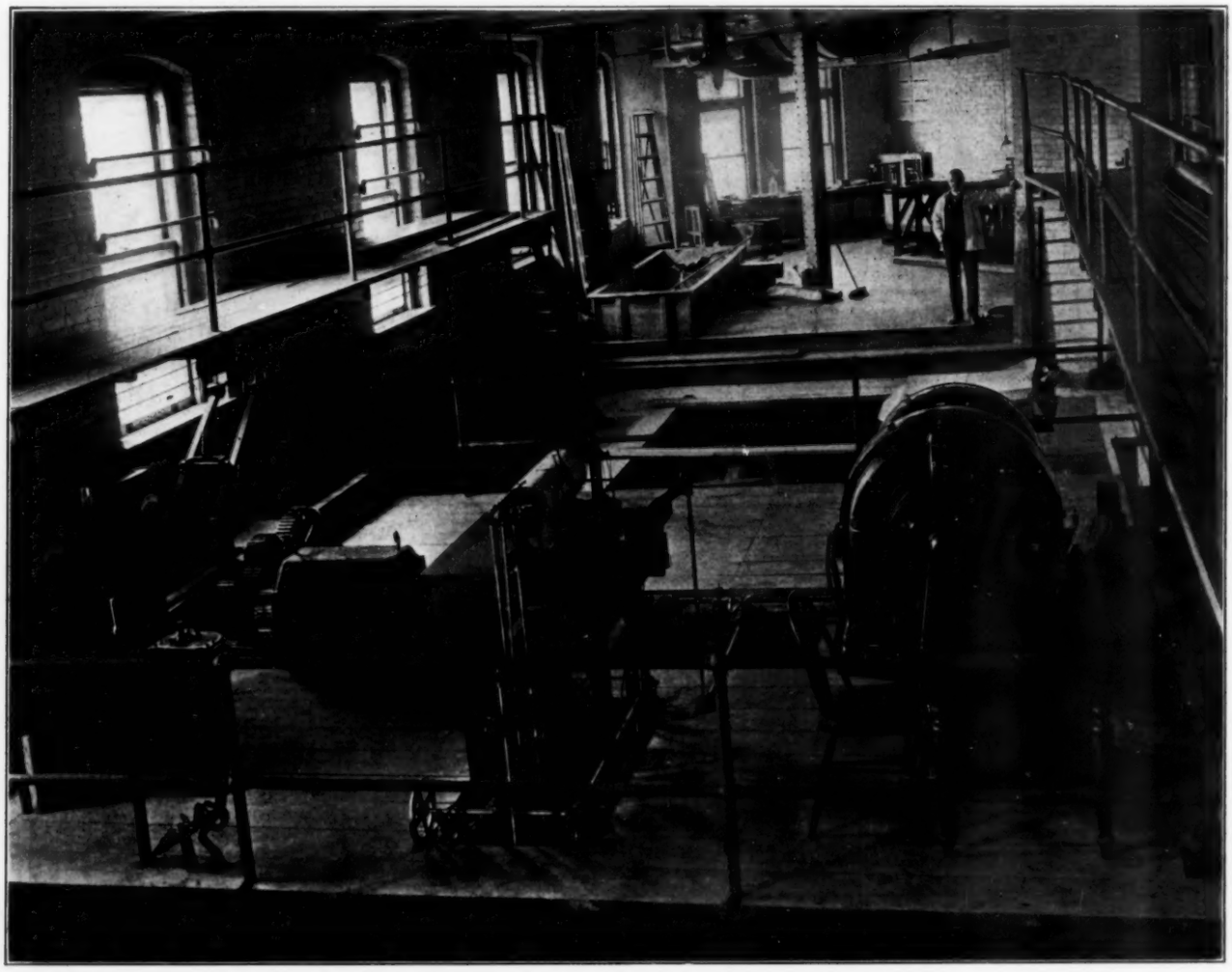


FIG. 2. TRAVELING TRUCK.

THE PREPARATION OF THE DRAWINGS AND MODELS.

The preparations of the models themselves will now be considered. The substance of which the models are made is paraffin wax with a mixture of about 4 per cent. beeswax. This material is the same as that used in most laboratories of this kind, and was chosen for the following reasons: It is very easy to handle, that is to say, it may be melted at a low temperature and cast without difficulty; it is also easily cut, planed or scraped; it enables us to have a uniform surface for all models, and when a model is not required for further experimenting it may be broken up and used for another of a different type.

Before casting a model a mold is first prepared. This mold is made in ordinary modeling clay. Sections of the vessel at different points in its length are first cut out of wood, about ¼ inch larger

than the actual size required. These are placed in the bed and the clay molded and faired in until it conforms to the proper shape. As the models have to be cast hollow, a core is next made. The forms as above are cut out so as to allow a thickness of paraffin wax of about 1½ inches. These forms are then connected together by thin wooden strips and covered with canvas, so that the core forms as it were a canvas canoe which is suspended inside the clay mold. The paraffin wax is then melted in a tank provided with a steam coil and the mold poured. While cooling considerable contraction occurs so that small quantities of melted wax must be added continually. While the wax is being poured, water is introduced into the inside of the core in order to overcome its tendency to float and also to aid in cooling.

When cooled the core is withdrawn and the model floated from its bed by introducing water between the walls of the mold and the model. The model is now in its rough state and ready to be cut to the correct form. It is next placed in the cutting machine (Figs. 1 and 4). This machine consists primarily of two tables, on one of which is placed the model and on the other the drawing of the lines which it is desired to reproduce. These two tables move together and are driven by a motor, the motion of the drawing table is, however, usually about one-half as fast as that of the model table; but this ratio can be varied by introducing change gears. The object of this is so that the drawings do not have to be made unnecessarily large. In the middle of the machine is a cross piece upon which are two traveling heads which move together inward or outward and are operated by a right- and left-handed screw by means of the handle shown on the right-hand side immediately over the drawing. These heads carry two vertical hollow spindles which have a screw thread cut on the outside. By means of a worm gear these may be raised or lowered to any desired extent, the amount of the vertical movement being measured by a scale and vernier upon one of them. Inside each spindle is a shaft which is driven by a vertical motor on the top, and to the bottom of which is attached a two-bladed cutter. As the in and out motion of the cutters must correspond with the breadth upon the drawing at various points, the motion of the cutters is transferred to the drawing by means of a pantograph. One end of the pantograph is attached to one of the cutters and the other movable or center part to a bar which is carried over to the drawing, and on the end of which is a pointer. If, for example, the drawing is one-half the size of the model, the arms of the pantograph are set in this ratio. When, therefore, the screw which operates the heads carrying the cutters is revolved, the cutters move in or out a certain amount, and the pointer on the drawing one-half this amount. As, however, the points of the cutters describe circles, the pointer is also a circle, but of one-half the radius of the cutter circle. (In cases where a different ratio of length to breadth from that as shown in the drawing is being cut, the pointer is an ellipse). In Fig. 1 it will be noticed that an adjusting lever is attached to the fixed arm of the pantograph, the reason for which is as follows: It sometimes happens that the drawing paper and hence the center line of the drawing may become warped. Under these circumstances the cutters would not be cutting the actual

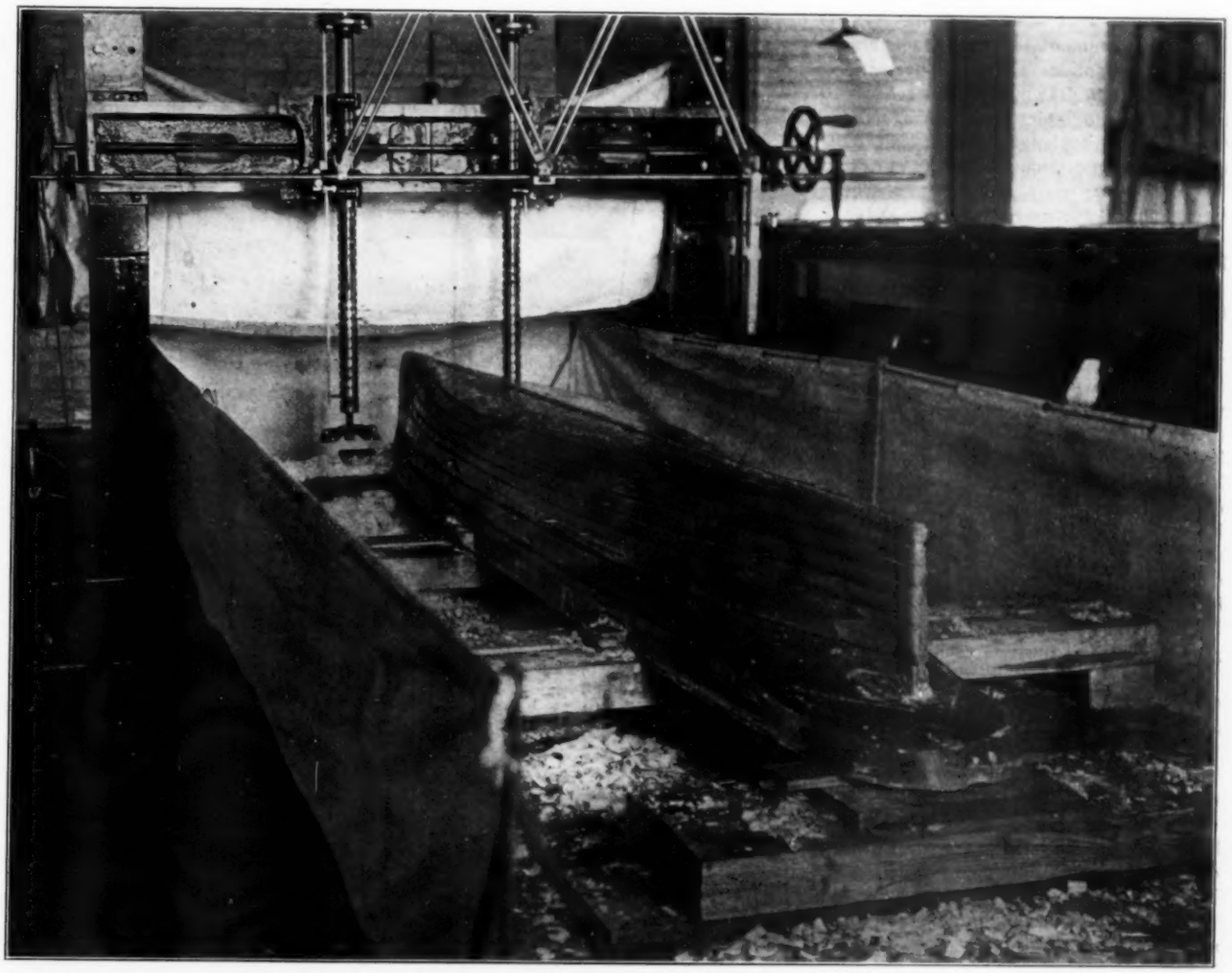


FIG. 4. MODEL-CUTTING MACHINE AT WORK.

breadth from the center line, but from some imaginary straight line. The end of this lever is therefore attached to a frame which carries a roller, which bears against a batten which is placed upon the center line of the drawing, no matter what form this has taken. If the center line is slightly curved the roller follows this curve and moves the fixed end of the pantograph a corresponding amount and therefore compensates for this error.

From one drawing it is possible to cut any number of models of the same form but varying in ratio of beam or draft to length. If a broader or narrower model is desired, all that has to be done is to alter the fulcrum of the pantograph and the relative motions of the cutter and pointer on the drawing are altered accordingly. If it is desired to change the ratio of draft to length, the amount by which the vertical motion of the cutters is changed for each waterline may be correspondingly increased or decreased.

The method of operation is as follows: The model is placed upside down upon its table, carefully centered and clamped down; the drawing is also placed upon its table and the center line adjusted. The cutters are now run up to the bottom of the model and moved in so that they nearly touch. They are then put into motion, as is also the table, and the base line or top of keel cut from one end to the other. The cutters are now lowered to a depth corresponding to the first waterline as shown on the drawing. The cutting is usually started from amidships and worked both ways toward the ends. The operator now runs in the cutters until the pointer is exactly upon the line required and starts the two tables moving. By operating the handle on the right- and left-handed screw, the cutters are gradually brought together and their motion transferred to the pointer. He must so regulate this motion that the pointer remains tangent to the line he desires to follow, while the drawing moves along. In this way the cutters are made to follow exactly any desired line. When one line has been cut they are lowered to the next and so on until all the lines have been cut. When this part of the work is finished, the model has the appearance as shown in Fig. 4, that is to say, a series of longitudinal grooves has been cut, which represent the correct shape of the various waterlines. It is now taken to the finishing table and the superfluous material between the grooves removed by a chisel, plane, or spokeshave until the grooves have almost disappeared. It is finally finished with a scraper and when the grooves have just disappeared and the surface is fair, it receives a final burnishing. The position of the desired load or any other waterline is now marked upon it at different points and check measurements are taken to see if the model is correct to the drawings. It is then carefully weighed and placed in the tank. The amount of ballast, which consists of shot bags, necessary to bring the model down to the desired load line, is also calculated and weighed out. This is now put into the model and moved until the latter floats upright and in her correct trim. This is the final check that the model receives, as it should float at its correct waterline when the calculated amount of ballast has been added.

The attachment for the towing and steering rods are now made and the model connected up to the dynamometer.

THE CALCULATION OF THE RESISTANCE OF A FULL-SIZED SHIP.

The models used are from 10 to 12 feet long, and may represent a vessel of any size. In order to predict the resistance of a full-sized ship from that of a model, Froude's "law of comparison" is used. The total resistance of a vessel consists of two parts, surface friction and wave-making resistance. The frictional resistance may be calculated for any kind of surface, whether paraffin, paint, copper, etc., from the knowledge of the corresponding coefficients of friction of these surfaces. If this be subtracted from the total, the remainder will be the wave-making resistance. According to Froude's law, this resistance varies as the cube of the lineal dimensions at corresponding speeds, i.e., at speeds varying as the square root of the lineal dimensions. For example, if a model were one forty-ninth the full size and were towed at a speed of three knots per hour, the corresponding speed of the full-sized ship would be $7 \times 3 = 21$ knots. If at this speed of three knots the wave-making resistance of the model were say three pounds, the wave-making resistance of the full-sized ship would be $3 \times (49)^3 = 352{,}947$ pounds (at 21 knots). To this must be added the frictional resistance, calculated as explained above, in order to obtain the total resistance of the vessel.

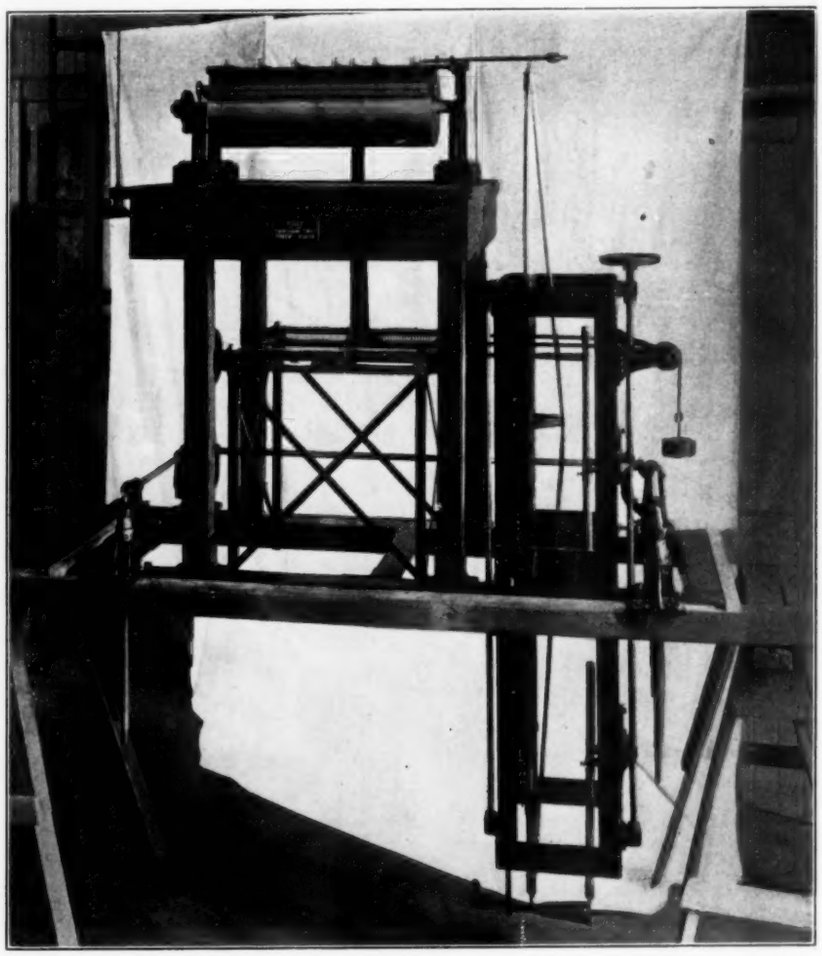


FIG. 3. DYNAMOMETER.

It is therefore possible to experiment with models at fairly low speeds and yet obtain results which correspond with high speeds in the full-sized ship.

The subject of resistance of ship's forms is one which requires a large amount of investigation, and it is expected that the work done at the university will help toward the solution of many problems and prove a benefit to the profession of naval architecture as a whole.

Convention of the American Boiler Manufacturers' Association

The eighteenth annual convention of the American Boiler Manufacturers' Association, held at the Hotel Schenley, Pittsburg, opened promptly on time Tuesday morning, Sept. 18. The convention was called to order by President Robert Munroe, Jr., of Pittsburg, and Mayor Guthrie gave the address of welcome. He was followed by several other speakers and then the president gave his annual address in which he made an urgent plea for the coöperation of all members in continuing the work of the association and referred to the output of the boiler manufacturers and kindred trades as exceeding $500,000,000, and employing 100,000 men. The manufacture of boilers he said should be recoginzed as a leading trade, requiring great skill and ability and of importance to the community, inasmuch as the failure to properly design or construct a safe boiler may cause great loss of life and property. The speaker stated that during the past few years labor conditions have been favorable and he was glad to say that labor and capital were getting closer together and that they will eventually work together for the common interest.

MONONGAHELA RIVER EXCURSION.

In the afternoon a pleasure trip was taken up the Monongahela river by many delegates and ladies, and through the thoughtfulness of the local committee, Geo. N. Riley, Robert Munroe, Jr., James Lappan and Capt. Thos. Rees, many little details contributed to the entertainment of the party. The various plants were easily identified by large canvas signs conspicuously displayed from the banks on either side of the river, and as the boat passed each it was greeted by a deafening salute from the whistles. The return trip was made in the evening, and in the gathering gloom the fires of the mills and the glow of the coke ovens made a beautiful illumination, and the changing lights and shadows falling on the hillsides verified the prediction of the committee, that the view of these plants in operation after dark would prove a very beautiful sight. Every now and then the uptilting of a slag conveyor sent forth an imitation lava flow down the river bank, glowing, sparkling and coruscating; again as the Duquesne mills were passed the blowing of bessemer steel sent upward into the night showers of sparks. And when the party finally reached the Schenley, all agreed that the trip had been most enjoyable and unsurpassed as an object lesson, setting forth these important industries.

COMMITTEE REPORT AND A TALK ON STEAMBOAT-INSPECTION LAWS.

On Wednesday morning the report of the Committee on Uniform Boiler Specifications was presented by its chairman, Col. E. D. Meier, and later an informal talk was given by Gen. George Uhler, inspector general of the steamboat-inspection service. General Uhler in his remarks explained the difficulties under which the board acts in interpreting and applying the steamboat-inspection law, many sections of which have, by reason of the vast increase in the steam tonnage of the country and the improvements made in engines, boilers and the materials of which they are constructed become obsolete, and in many cases even worse than that, tending to intensify the very evils which they were originally intended to correct. A single instance of several given in his remarks shows this very clearly. The steamboat law was in the beginning mainly based on conditions existing on our Western rivers. In order to have the pump for fire service, for instance, ready at hand for the engineer, the law prescribes that no pump for fire service shall be placed below the lower deck of a vessel. On a Mississippi river steamboat this means the same deck on which the engines are located, so that the engineer need only turn around or make a very few steps to at once reach the fire pump, on which depends the safety of the vessel in the event of a conflagration; but the lower deck on a steamship as understood in the lake and saltwater services is several galleries or platforms above the post of the engineer; yet, by the distinct provision of the law, the fire pump has to be placed in this position that would be known as the lower deck of a vessel, and the object sought by the law, that is, to have the fire pump ready at hand for instant use by the engineer, is thus rendered nugatory. Yet it took several years of active discussion by steamship owners, with the full co-operation of the Board of Supervising Inspectors, to have this language modified so that the safety sought might be insured.

The speaker then explained that Sec. 433 of the present law works a disadvantage to manufacturers generally in that they are prohibited from constructing a boiler that would be for all intents and purposes a better boiler than might be constructed under the present law, and he suggested that the efforts of the association should be directed toward the repeal of this law rather than to discussing its obvious disadvantages in practice. He further enlarged upon the possibilities of material—steel particularly—and urged that good steel can be manufactured under present specifications, a statement which he fortified by presenting samples of materials that were remarkable both from their tensile strength and their ductility. He believed our material to be superior and our design and construction equal, if not superior, to any of foreign origin or production, and that the present steamboat-inspection law, although in some particulars imperfect, is equal to the inspection laws of any nation upon the face of the earth.

DISCUSSION OF VANADIUM ORE AS AN ALLOY FOR STEEL.

At the afternoon session on Wednesday, B. E. D. Stafford, of the Flannery Bolt Company, Pittsburg, exhibited to the convention a number of steel sections showing results obtained by the use of vanadium ore as an alloy for steel. In the discussion following, it developed that Mr. Stafford's company is not in any sense a maker of steel, but a miner of vanadium. Of the large number of samples exhibited by him, No. 18, for instance, showed 148,500 lb. per square inch, tensile strength; elastic limit, 141,000 lb.; torsional strength, 140,000 lb. with 1½ twists. The speaker stated that this sample was practically of vanadium nickel steel with a small proportion of nickel and 0.25 per cent. vanadium. He said that all the tests proved that vanadium has a tendency always to increase the elastic limit and elongation, and this is what makes it so vital a steel in European practice.

ELECTION OF OFFICERS.

The following officers were elected to serve during the ensuing year: President, M. F. Cole, Newnan, Ga.; secretary, J. D. Farasey, Cleveland, O.; treasurer, Joseph F. Wangler, St. Louis, Mo.; first vice-president, John J. Main, Toronto, Canada; second vice-president, J. Don Smith, Charleston, S. C.; third vice-president, William H. Fletcher, Hoboken, N. J.; fourth vice-president, N. D. MacKinnon, Bay City, Mich.; fifth vice-president, H. Goldner, Philadelphia, Pennsylvania.

AN INTERESTING PAPER ON BOILERS.

On Thursday morning a short session was held, the balance of the day being devoted to entertainment.

At the business session a paper was read by Past President H. J. Hartley, of the William Cramp Ship and Engine Building Company, describing some boilers recently constructed by that company under his supervision, notable in character in regard to strength and thickness of materials entering into their construction, and also being the heaviest and highest pressure Scotch marine boilers ever constructed in this country. They are designed to carry a constant working pressure of 234 pounds per square inch for the purpose of supplying steam for two 7500 horse-power triple-expansion engines for propelling two 7000-ton ships now in the course of construction at the Cramp yards for the Southern Pacific Steamship Company, to be used in its passenger and freight traffic between New York and New Orleans. Each of these ships contains four single-ended and three double-ended boilers; the single-ended type being 15 feet 4 inches in diameter by 11 feet long, each containing four Fox corrugated furnaces, 3 feet 5½ inches

in diameter by 8 feet 8 inches long and 11/16 inch thick, and each having a separate combustion chamber. The double-ended type is of the same diameter, but 21 feet 4 inches long, each containing eight furnaces of the same size and type, with separate combustion chambers also. The aggregate grate surface contained in the boilers for each ship is 770 square feet, and the heating surface 26,464 square feet, making the ratio of heating to grate surface 34¼ to 1.

The shells of both the single- and double-ended boilers are composed of plate steel, 1 11/16 inches thick, double butt strapped and riveted with 1½-inch diameter rivets throughout, each rivet weighing from 2¾ to 4¼ pounds. The sizes of the plates in each length of boiler vary from 5 feet 9 inches x 24 feet 7 inches, to 7 feet 8 inches x 24 feet 1 inch, and the weight per plate from 9817 pounds to 13,000 pounds, respectively. The weight of each single-ended boiler, without fittings, is 65¼ tons, and that of each double-ended boiler 119½ tons, making the total weight of boilers, exclusive of fittings for each ship, equal to 620½ tons.

The boilers were constructed under Lloyds' rules, requiring a hydrostatic test equal in pressure to double that of the working steam pressure, or 468 pounds per square inch. This, however, was not strictly adhered to, on account of the vessels not being immediately registered under Lloyds' rules, and the United States Government rules not requiring such a high hydrostatic-test pressure by 50 per cent., a compromise equal to 361 pounds was substituted, under which test the boilers proved to be unusually and remarkably tight.

Mr. Hartley said that the bringing about of the possibility of having this high grade of boiler-plate steel manufactured had its inception in Pittsburg, 18 years ago, in the formation of this association, which had for one of its objects the consummation of a uniform specification, by which a higher grade of steel boiler plate should be made, even regardless of the cost if necessary. He added that notwithstanding what has been accomplished in this respect, still greater exertions are destined to be put forth by the boiler manufacturer in grappling with the construction of boilers capable of sustaining higher steam pressures than have ever yet been required for commercial motive power.

In this connection he stated that he was recently verbally informed by a noted superintending engineer of one of the steamship lines plying between New York and the South Atlantic ports, that the future new ships to be built for his company's line would be equipped with engines requiring working pressure of steam approaching 300 lb. per square inch, even if the boilers had to be reduced in diameter to safely carry that pressure.

Gen. Uhler, who was an attentive listener to the foregoing paper, said he understood that the ships in question were to use superheated steam. This would mean the practical elimination of composition material for valves and fittings, which material disintegrates at temperatures ranging at about 400 degrees. The speaker had no doubt that the time is not far distant when steel is going to supersede everything in the nature of conductive compositions for steam, which, with such high pressures, will naturally have to be superheated. The day of the old copper pipe is fast waning, and its prestige is now practically gone. Composition valves formerly thought to be the only thing in the world to withstand the stress of high pressure, more particularly superheated steam, have given way practically to steel body valves, etc.

The business of the convention was concluded at this session. The final feature was the annual banquet, which was held Thursday night.

What is Wrong with Piston Pins in Automobile Engines—The Remedy

BY E. J. BARTLETT, E. E.

One of the causes of the serious mishaps which sometimes occur to gasolene automobile motors is a defective piston pin, either from point of design, material, or method of holding it in the piston. A failure of this part usually results in at least a scored or broken cylinder, and not infrequently a broken crank-case or shaft. A cylinder once badly scored can be made to hold its compression only by reboring, assuming the wall is thick enough to permit this, which is not always the case in small automobile engines. As most multi-cylinder engines have two or more cylinders cast together, the expense and annoyance of repairing is considerable. In any event, the failure of a piston pin is an accident to be very carefully avoided, and it is a wise precaution to occasionally inspect these parts.

Aside from the piston itself, the pin takes more of the explosive force of the gases than any other part of the engine, and as lightness, as well as strength, is essential, good material should be used in its construction. As it is subjected to considerable heat, it must be well lubricated; and last, but not least, it must be securely fastened against any tendency to "float."

The stresses the pin is subjected to are those of bending, due to the explosive force of the gases, and the inertia of the moving parts. A negligible torsional strain is also introduced by friction.

Of these the explosive pressure only need be considered as it will set up the highest possible stress at or near the dead center, except in cases where standard practice is departed from to the extent of exceptionally heavy parts and high speed.

The pressure per square inch exerted by the gases at the instant of explosion is roughly four times the absolute compression pressure before ignition. Practice shows that 450 pounds pressure per square inch is a safe estimate, with a reasonable factor of safety in the strength of the parts.

It is quite general practice to make the length of the bearing in the piston end of the connecting rod one half, and the diameter of the piston pin, if solid, one-fourth the diameter of the piston. Hollow pins are generally used, however, to facilitate lubrication, fastening in place, and to give sufficient projected area for bearing. The strength then should be equivalent to that of a solid pin whose diameter is given by the above ratio.

Adhering to the standard practice, so far as there is any, and assuming a piston four inches in diameter, we may find the strength of the material suitable to use for the piston pin. It must be remembered, however, that the results found by applying the following formula are to be taken as a check only, and used with good judgment in selecting a steel which will stand up to its work under the rapidly occurring shocks and heat incidental to the working conditions of a piston pin, as well as having the required strength.

In the example noted, the area of the piston is about 12.5 square inches, and at 450 pounds pressure, the total load on the pin is about 5600 pounds.

For a circular beam supported at the ends and uniformly loaded, the relation between load, fiber stress, and dimensions may be expressed by the formula

$$P = \frac{\pi S d^3}{4 l}$$

where P = load in pounds,

S = working stress of the material in the beam,

l = length of beam in inches,

d = diameter of beam in inches.

Solving we find the value of S to be about 14,300 pounds per square inch. With a factor of safety of six this becomes 90,000 in round numbers as the required elastic limit of the material used in the piston-pin construction. Any steel having, and retaining this strength, or a greater, when working, and possessing the necessary shock-resisting qualities may be used with safety. Some of the chrome-nickel alloys are probably the best material obtainable for this purpose, though a material whose strength is much in excess of the required amount is not necessary, as the projected area of the pin must be within the sizes noted, and additional strength of material will not allow a smaller pin to be used. A 35 to 40 point carbon steel with not over .02 per cent. phosphorus will be found satisfactory in ordinary work.

The pressure per square inch on the projected area of the pin varies considerably in practice. It may safely be left out of the problem if the size of the pin is determined as explained above, making

the bore of the hollow pin about one half the diameter. If it is desired to check this result 1000 pounds per square inch may be taken as an average of the pressures used in practice.

Some of the more common methods of holding the piston pin from endwise motion are shown in the sketches. It will be readily seen that designers are not agreed on this important detail. In fact, any of these methods are satisfactory if the parts are carefully assembled, but unfortunately the machine and repair man cannot always be depended upon to do the work right, so the method used should leave as small chance for error in assembling as possible. The methods shown are frequently modified somewhat. One or both ends of the pin are secured, and often one end is tapered or necked down to fit a corresponding hole in the piston hub so the pin can come out one way only, though the advantage of this construction is somewhat questionable; for if the working device holds, a straight pin is all that is needed; and if it fails, a pin tapered at one end will work out all the easier.

The principle shown at *A*, Fig. 1, is perhaps the best, and consists of a taper locking pin, the small end of which may be split and carefully spread, or it may be secured by a cotter pin. An ordinary taper pin may be used, as indicated, though a more convenient device is a special taper pin with a threaded head. A special wrench may then be inserted from the bottom of the piston and screwed over the head of the taper pin, making it easily removable. The taper pin, when nicely fitted, holds the piston pin perfectly rigid, as it should be held. None of the other methods described has this feature, excepting the one illustrated at *E*, Fig. 3.

At *B*, Fig. 1, is shown a very positive method. The locking pin or bolt is inserted through holes in the piston wall, which are not objectionable, and secured by carefully prick punching the ends if a pin, or by a castle nut and cotter pin if a bolt.

The locking screw at *C*, Fig. 2, passes through one side of the piston pin, its point resting on the opposite side, thus putting the threads of the screw in tension.

In the method represented at *D*, the threads of the locking screw are put in tension by screwing the head tightly against the piston hub, the point of the screw resting in a groove in the piston pin. Either this device or the preceding one would seem somewhat questionable, particularly if the threads of the locking screws were loose. A screw in each end of the piston pin, either of style *C* or *D*, locked together with a piece of wire as shown by method *D* is positive. The greatest difficulty is to keep the wire away from the connecting rod.

E, Fig. 3, shows a very good method in which the piston pin is held by a screw dowel tapped into it and the hub of the piston, and locked in place by a cotter pin.

At *F* is represented a piston pin with its end slotted and spread by a taper plug. This would seem to be somewhat wrong in principle, as the pin is held tightly at the extreme end only, and the fit is not uniform; this, in connection with the weakness caused by the slots, would tend to let the pin spring and make it difficult to hold it by the method used.

Another method, not shown, is to use an extra piston ring crossing the piston-pin hole. This allows the pin to float a little, which it should not do. The connecting rod is sometimes a little out of line, which forces one end of the pin hard against the ring, sometimes causing trouble.

Enough discussion and methods have been given to show some of the ways this problem is handled in automobile work. The results of a defective piston being so important considerable time and, if necessary, expense should be spent on making this part do its work right.

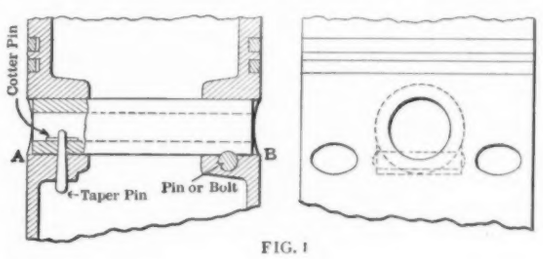


FIG. 1

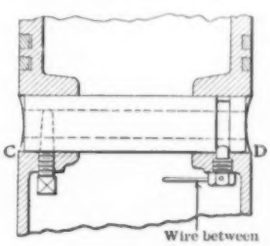


FIG. 2

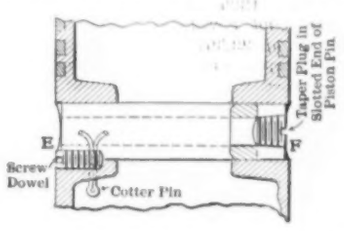


FIG. 3

PISTON PINS IN AUTOMOBILE ENGINES.

The Attitude of Japan

Eki Hioki, Chargé d'affaires of Japan at Washington, delivered an address before the National Geographic Society in January, which we find printed in the *National Geographical Magazine*. In this address the speaker said:

Of course, everybody knows that the essential factors of industry are labor, capital, and material. Labor is only one of the three, and in our days of machinery its importance has become comparatively insignificant. The history of your own industrial progress has proved this fact. There was a time when the same cry was raised in this country as to European competition on account of their cheap labor, but where stand your industries now? Japan has labor, but the advantages which this country has in the remaining factors of industry are incomparably greater. In addition you have an immense advantage over other nations in your wonderful inventive genius. In the modern system of industry, no human labor, however cheap, can compete with machinery. Besides, labor in Japan does not remain cheap. The effect of the China-Japan war was to double the price of labor. The war with Russia must have raised it very much higher. In spite of all these disadvantages, Japan must develop her commerce and industry and she will have to compete with all the world, friend or foe. It is an absolute necessity for her very existence. But, with an unflinching determination to push her commerce and industry to the forefront, Japan will not resort to "ways that are dark and tricks that are vain." Her commercial war will be fought just as fairly and stoutly as the real war. In China, Japan seeks no unfair advantage. She seeks no favor from China that is not granted to the United States, England, or to the entire world. She stands for the open door, and, in the words of your great President, a "square deal."

Under these conditions, Japan is willing to enter either into an alliance or rivalry of trade with any nation. Japan welcomes capital and material from any country. The United States is supplying materials for our important industries. Why cannot she supply the capital, too? There exists between Japan and Great Britain a political alliance in the East; why can there not be a commercial alliance between Japan and the United States? We are willing to divide a fair share of profits, wherever gained, with any people. The field for the commercial and industrial activity of Japan has been immensely enlarged as a result of the last war, and this offers a specially favorable opportunity for American coöperation. With the cheap labor and a comparatively superior knowledge of Oriental matters possessed by the Japanese, combined with the inexhaustible supply of American capital and materials, we can build up an impregnable commercial stronghold in the East which can defy the rivalry of the world.

The Care of Belts—Erratum

Page 309, third column, sixth line from the bottom, for "1 inch per 100 feet" read "1 inch per 10 feet."

AMERICAN MACHINIST

Issued Weekly by the

Hill Publishing Company

505 Pearl Street, New York.

Also Published at 6 Bouverie Street, London, E. C.

Correspondence on mechanical subjects solicited and paid for. Name and address must always be given—not necessarily for publication.

Address all business communications to the American Machinist, 505 Pearl Street, New York. Matter for reading columns may be addressed to the Editor.

Subscribers can have address changed at will. Give old and new addresses. Date on wrapper denotes end of month in which subscription expires.

Subscription price $4 per year, postage prepaid, to any post office in North America; $5 in all foreign countries except Europe and British possessions in Eastern Hemisphere.

The AMERICAN MACHINIST CO., LTD., 6 Bouverie St., London, E. C., will serve all subscriptions for Europe and British possessions in Eastern Hemisphere. Price 30 Shillings for England. For all other countries in Eastern Hemisphere, 35 Shillings.

No back numbers beyond current year. For sale by all newsdealers generally.

Entered at New York Post Office as mail matter of the second class.

Cable Address, "MACHINIST," N. Y.
Lieber's and A B C Codes.

During 1905 *the* AMERICAN MACHINIST *printed and circulated* 1,059,100 *copies, an average of* 20,367 *per issue. Of this issue* 29,000 *copies are printed. None sent regularly free. None taken back from newsstands. No back numbers beyond current year.*

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Why Machinists Do Not Read

The subject stated above has been considerably discussed in our columns of late, but of course, and necessarily, by readers, i.e., by machinists or others engaged in machine-construction work who do read. It is, in the nature of the case, difficult to get at the opinions of the men who form the subject of the discussion, i.e, those who do not read, because it is equally certain that such men do not write and will not.

EXPERIMENT WITH A READING ROOM.

We have before us a letter from a reader who has been studying the problem of the non-readers, and who has made some experiments which he describes.

He is connected with a large establishment receiving many technical journals. A space was partitioned off, these papers arranged in it, and the men invited to take and read them. At first some did so; but their number decreased, and finally there seemed to be no encouragement for the further continuance of the experiment.

After relating what was done and the results of it, our correspondent says:

"I expected that some of the twenty-five or thirty draftsmen and testing men would use the library, but they showed the least interest of all.

"I think the shop man does not read technical matter and shop papers, because he has not been 'brought up' to it; and also one seldom attaches much value to anything one gets free of cost. Had the men paid for the subscriptions to these papers, they would have simply devoured them—to get their money's worth—or have stopped reading them and felt that they were 'stuck' the subscription price. I think that in many cases the men are induced to subscribe to papers by a good talker, who gets his money on the spot or works the instalment plan and the men's enthusiasm immediately fades away.

"I was not a little surprised to note that the draftsmen were so completely uninterested. Some said that they already subscribed to one or two papers, while the majority thought that the AMERICAN MACHINIST was a shop paper and was of no value to them.

"The general trend of questions about papers and the reasons for not continuing to take out papers, was to the effect that a man expected to find full and complete information upon the particular subject in his mind at that moment, all in the one paper that I would recommend to him as the one best covering his subject.

"Popular semi-scientific papers were most demanded. These papers contain nothing of value to the man in his trade, but perhaps serve the same purpose as the funny sheet of the Sunday papers—pleasing reading to him—though I will admit that they do spread information of the world's progress in new and startling things, in a garbled form.

"I have not entirely given up the idea, but, in the last few days have posted notices that there are many different mechanical and electrical periodicals available which I shall distribute to those wishing them. I am told that I am wasting my time, but I do not think so if I can get hold of three or four young men who have the brains and ambition to grasp and develop every little assistance."

SAYING THAT "EVERYBODY READS IT."

We know of men, themselves readers of this journal, who will readily say and do habitually say that "everybody reads the AMERICAN MACHINIST." Of course everybody does not, but the speaker thinks they do simply because the men with whom he is associated—the men who are his friends (because like-minded and similarly situated) are readers of it. For the moment he forgets the existence of the multitude—the masses who read not at all except to be amused. The society folk of New York think that in July and August "everybody" is out of town. Everybody who comes within their cognizance is out of town, but the millions of others remain and work.

Any well and conscientiously conducted technical journal will, without difficulty, obtain and retain a certain number of readers. Those will be picked men who are either so interested or so determined to make use of every means of advancement in their business that it would be difficult to prevent them from carefully reading everything of value having a bearing upon it. The others must be sought out, and when found, only a small percentage of them will be retained permanently. Most of these are destined not to succeed in the business but here and there among them will be an individual who is efficient and successful in his own particular line, but to whom a printed page is somewhat repellent. In type he will be utterly uninterested in a thing which, if given to him in the same words personally, by the author, would greatly impress and interest him. There are those who themselves seldom or never read, and do not enjoy reading, yet who like to have others read to them. Others again dislike both; their knowledge of the world and of its thought and progress being confined to that which they themselves see, hear and experience.

MEN SELECT THEMSELVES.

A process of natural selection goes on all the time in connection with the subscription lists of technical journals. In one way or another many are induced to subscribe for, or at least read them. Of those who thus begin in any one year, only a very small percentage will continue for say five years; the rest will go out of the business, will lose their ambition to succeed in it, become uninterested or even disgusted with all that pertains to it.

Others are congenitally narrow minded. If they work in an automobile shop they will, perhaps, read an article about a machine used in boring automobile cylinders, but will fail to see anything of interest in identically the same machine, when described as a pump-cylinder boring machine.

WHAT'S IN A NAME.

In a large American city there is a shop, over the door of which is the name of a man known all over America and Europe as one preëminent in a certain branch of mechanical engineering. Under this name is the single word "Machinist." The owner of the shop invents, designs and builds machines of many kinds, many of them of the most intricate nature. His idea of a machinist is a man who can do or does do those things. As a mathematician, draftsman and designer, as well as a practical mechanic, he has few equals, and in addition is a successful business man and manager. He calls himself a machinist because it is his business to make machines, and it is in this broad sense that the name of this journal was chosen 29 years ago at the suggestion of a man who is himself, and was at that time, a most expert draftsman and a machine designer of international fame.

Many of the leading teachers of mechanical engineering in this country and abroad make much use of this journal in their teaching and advise that it be carefully read by students and graduates. In view of these facts and many others that might be cited, the notion held by a few draftsmen that this journal is of interest or value to the man who cuts metals and to no one else is somewhat grotesque. It is designed for and is of interest to all who have to do with the art and business of machine construction. Those who are engaged in the business and who take some pains to be well informed as to the facts pertaining to it, soon discover that; we do not worry much about the others; most of them don't count. Our correspondent does right when he still tries to reach the few who can be reached; and whom it is worth while to reach. They select themselves, so to speak, but the more endeavor is made to find them the better for all concerned.

Nearly 30 years ago Chordal wrote, "Is there no show for machinists, Mr. Editor? Turn to the last pages of the AMERICAN MACHINIST and there read the biography of the working man. The advertising pages tell the tale. Sixty men* put their names on those pages. They employ five thousand workmen, and over six million dollars of capital. Were these sixty men born with these millions in their pockets? Did they fall heir to the cash and the shops at an early age? Not a bit of it. Among these sixty men can be found the names of some of the highest social powers in this land of ours. High-toned society made no exception among the five thousand and sixty. Society never said to one of the sixty, 'We find a birth mark on you; twenty years from now come to us.' Society never said anything. The sixty said. The five thousand in the shops never said to the sixty, 'We see a mark on you; shoot ahead and we will lag and work for you.' The five thousand never said anything. The sixty said."

In other words the sixty made use of every means of advancement, including the careful reading of all that could help them in their business. It is safe to say that the names of most of those who, ten to twenty years from now, will be among the leaders in the machine business are today on our subscription list and will stay there, reading rooms or no reading rooms.

*Now about 480.

The New Italian Tariff

The new Italian tariff which went into effect this year provides that import duties are to be collected no matter what may be the condition of the goods when they arrive at their destination. Detached parts of an article are dutiable as that article, even though the parts may each be packed in separate packages.

The following rates are of interest, the first being the Conventional or Most Favored Nation, and the other the General rate. When there is only one rate given it applies to all countries:

Motor cars for ordinary roads, weighing 50 kilos or less, $40 each; more than 500 up to 1000 kilos, $80 each; more than 1000 kilos, $120 each.

Machine belting, of leather, $17 or $20 per 100 kilos. Cast iron in castings, planed, turned, or otherwise wrought, $1.40 per 100 kilos.

Iron and steel, simply rolled or drawn: Rolled or hammered in rods or bars, of any section, not having in section any diameter or side of 7 millimeters or less, $1.20 or $1.30 per 100 kilos; having in section one or more sides or diameters of 5 millimeters or less, $1.80 per 100 kilos. Rolled in sheets: 4 millimeters in thickness and above, $1.40 per 100 kilos; less than 4 millimeters, but more than 1½ millimeters, $2 per 100 kilos.

Articles principally manufactured from heavy pieces of iron and steel, including articles the greater part of which is made from wrought or cast iron or steel, weighing over 25 kilograms, also articles the greater portion of which is made from rolled or drawn iron or steel and whose section does not present a side or diameter of 7 millimeters or less: Planed, filed, turned, perforated, etc., on a small part of their surface only, i.e., with a few plain holes, or slightly filed or hammered, $2.10 per 100 kilos. Planed, filed, turned, perforated, etc., on the entire or chief part of their surface, $2.65 or $2.70 per 100 kilos.

Steel springs of all kind, $3.60 per 100 kilos.

Fine tools and implements: Enameled, lacquered or oxidized, $4.40 per 100 kilos; other, $1.40 or $1.50 per 100 kilos; machine tools for working wood and metals, weighing 50 kilos or less, $3.20 per 100 kilos.

Guns: Complete, $160 per 100 kilos; parts of, $60 per 100 kilos.

Machine boilers: Multitubular, $2.80 per 100 kilos; other, $2.40 per 100 kilos.

Machine tools for working wood and metals, such as saws, planes, lathes, screw machines, drilling machines, etc., $1.80 per 100 kilos.

Steam engines: Fixed, without boilers, $2.40 per 100 kilos; semi-fixed, with boiler, hot-air, compressed-air, gas and petroleum motors, including rotary motors, $2.40 per 100 kilos.

Hydraulic machinery and water or wind motors, $2 per 100 kilos. This includes turbines, hydraulic wheels, pulsometers, pumps, and elevators, presses, accumulators, jacks, etc.

Locomotives without tenders, $2.80 per 100 kilos.

Dynamo-electric machines: Weighing more than 1000 kilos, $3.20 and $6 per 100 kilos; weighing 1000 kilos, or less, $5 or $6 per 100 kilos.

Machinery, not specially mentioned, $2 per 100 kilos.

Foundry Supply Association

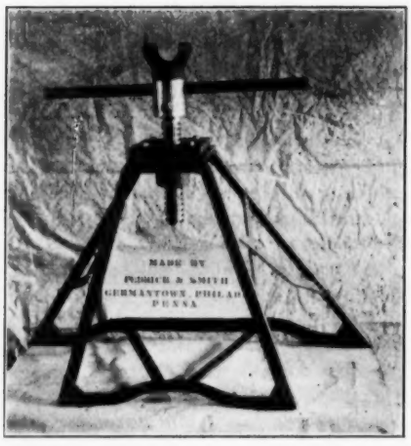
At the recent Cleveland convention of the American Foundrymen's Association a meeting was held by supply dealers and members of a local organization known as the A. F. A. Exhibit Association, which resulted in the formation of the Foundry Supply Association. The object of this organization is to coöperate with the American Foundrymen's Association for the general betterment of the foundry trade, by the introduction of improved methods, machinery, etc., into foundries. To carry out this work to the best advantage, the association will meet at the annual convention of the American Foundrymen's Association and, if advisable, hold an exhibition of foundry supplies and equipment in connection with the convention. It will also coöperate with the A. F. A. and the local foundrymen in the city where the annual convention is held, in arranging for the entertainment features. All firms, or individuals manufacturing or dealing in foundry supplies, equipment, or material are eligible to membership. S. T. Johnston is president of the association, and H. M. Lane, of Cleveland, secretary.

U. S. Consul G. E. Eager, of Barmen, reports that an engineer of Frankfort has invented an automatic postage-stamp selling machine which not only sells the stamps but sticks them on the letter.

NEW TOOLS AND MACHINE SHOP APPLIANCES

A CABLE-DRUM JACK.

The illustration shows a jack for lifting cable drums used by telephone and electrical companies. It is of light, but rigid construction, being made of structural steel. The standard-size jack will lift 28 to 36 inches, and weighs 60 pounds.



A CABLE-DRUM JACK.

This jack is made by Pedrick & Smith, Church Lane and Philadelphia & Reading railway, Germantown, Philadelphia, Penn.

A DRILL-PRESS CHUCK.

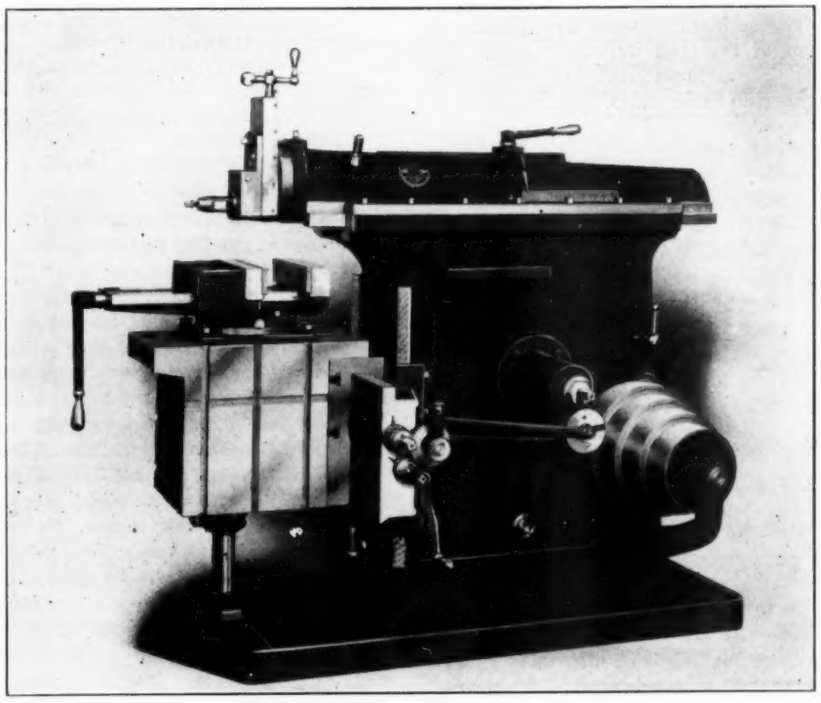
The illustration shows a chuck for use on the drill press. It will hold flat, round, straight or taper work and is self adjusting to the shape of the work it is holding. The steel blocks used in this chuck are planed from bar machinery steel; they may be easily removed and used as ordinary V-blocks or parallel blocks; the steel jaw-faces are also removable. The flange around the body of the chuck is planed square and true with the jaws for convenience in setting and clamping on the table.

The chuck is 6 inches wide by 1 11/16 inches deep, it will open 2 inches with both blocks in, 4 inches with one block in place and 6 inches with both blocks removed.

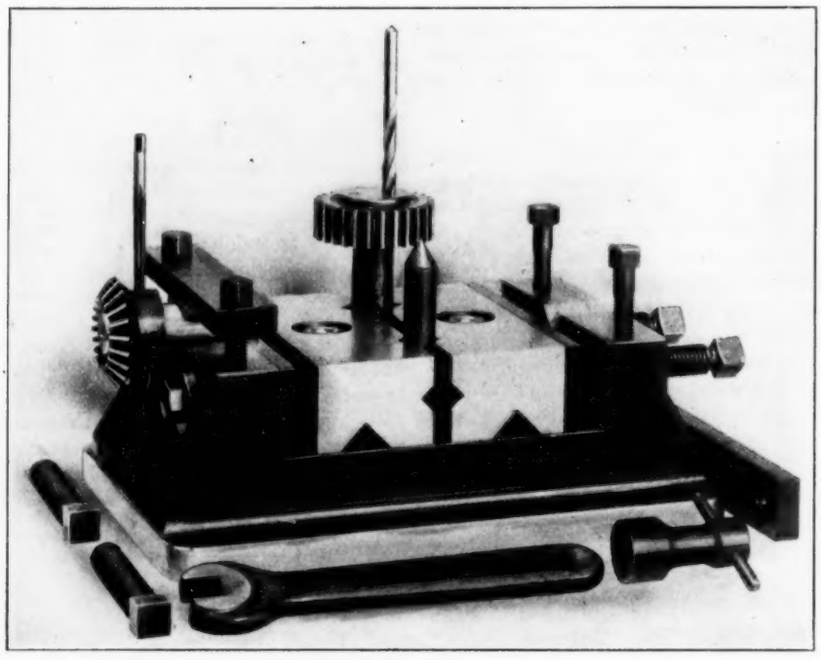
It is made by the Cincinnati Machine Tool Company, Cincinnati, Ohio, U. S. A.

TWENTY-INCH BACK-GEARED CRANK SHAPER.

This newly designed tool is constructed with heavy column and ram and substantial rail and table, the outer end of the latter resting on an adjustable support adapted to slide along the front of the base. The column is well reinforced, and its base is in the form of a pan for catching chips and oil. The ram bearing is 10½x36 inches and the opening underneath allows shafting up to 3½ inches diameter and of any length to be key-seated. The cross-rail has an 8½-inch front and a 1 7/16-inch top-bearing surface for the apron, and both the cross-traverse and the telescopic elevating screws are provided with power-feed and ball thrust bearings and also with adjustable graduated collars reading to 0.001 inch. The feed-connecting rod adjusts itself to any hight of rail and has a positive drive easily adjusted for the desired feed. The apron has a taper gib and at the bottom there is an adjustable clamp plate. The table has beside the T-slots a V for holding shafts or similar work vertically and the swiveling vise shown has 12x2½-inch jaws opening 14 inches and which in operation are drawn and not pushed together. The ram is 45 inches long, has screw adjustment for length of stroke and the posi-



TWENTY-INCH BACK-GEARED CRANK SHAPER.



A DRILL-PRESS CHUCK.

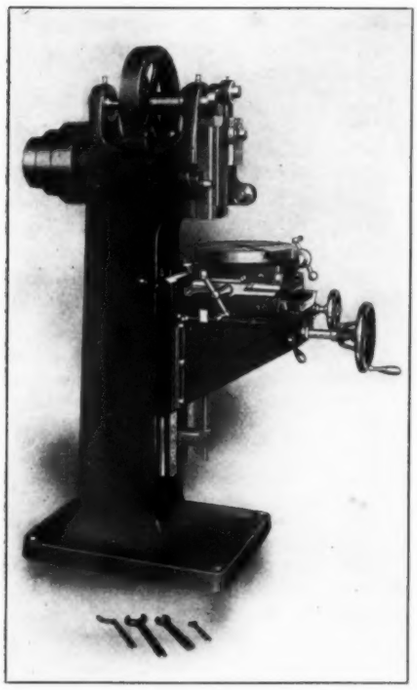
tion can be changed with the machine in motion and without the operator leaving the work. The swiveling head is clamped by an improved device that draws it squarely against the ram. The gearing in the shaper is so arranged that it may be operated either single or back geared, the ratios being 6 to 1 and 22 to 1, and the number of strokes per minute ranging from 8 to 72. The shafts are of high-carbon steel and ground to size; the bearings are bushed and are self-oiling. The table measures 13x21 inches on top, and 14x15½ inches at the side; it has a traverse of 25 inches and a vertical movement of 14⅝ inches. The head has a feed of 7½ inches. The four-step cone is driven from a countershaft running at 280 turns per minute. The machine weighs 2800 lb. and is built by the Rockford Machine Tool Company, Rockford, Ill.

A DIE-SLOTTING MACHINE.

The illustration shows a machine for slotting dies, internal and external gear patterns, where draft is required, and all kinds of small slotting and keyseating, both straight and taper.

The knee of the machine is of box construction. Hand wheels provided with micrometer dials control the movement of the knee and the movements of the saddle.

The handle for the rotary table is arranged for using dials for dividing purposes, but for small divisions and rapid work it may be removed and the table revolved by hand using a locking-pin device which gives figures having 2, 3, 4, 6, 8 and 12 sides.



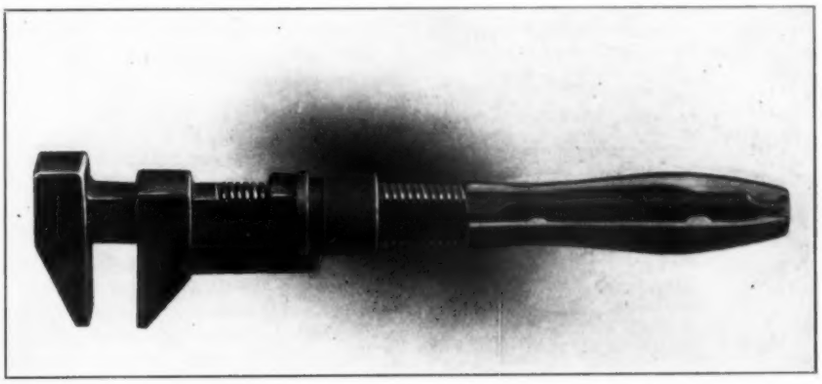
A DIE-SLOTTING MACHINE.

The stroke of the machine is 2½ inches and is not adjustable. The slide of the ram can be swiveled to an angle of 5 degrees either way and set to a graduated index.

The tool block swivels on a center near its lower end; at the upper end are two hardened plugs (carried in a yoke) which bear on a cam in the lower end of the connecting rod. This arrangement locks the tool block on the down stroke but causes it to clear the work on the up stroke. This machine is built from new patterns and designs by the Garvin Machine Company, Spring and Varick streets, New York.

A STEEL-HANDLED MONKEY WRENCH.

The illustration shows a monkey wrench designed for the hardest kind of use. A special feature of this wrench is the steel handle. As everyone who has worked around machinery knows, the wooden handles of monkey wrenches are liable to become loose and fall off or be broken off through abuse, such as using the wooden handle as a soft hammer. In some cases the wooden handle is replaced with a piece of pipe, but this seldom makes a satisfactory repair.



A STEEL-HANDLED MONKEY WRENCH.

The steel handle of this wrench is forced on the bar, under pressure, and is then hot-riveted in place, making it practically one piece with the bar. As the handle fits the rectangular bar it cannot roll as a piece of pipe would. The illustration shows the construction, the handle being partially cut away for the purpose. This wrench is made by Bemis & Call Hardware and Tool Company, South and Main streets, Springfield, Mass.

A PLAIN RADIAL DRILLER.

The illustration shows a 4-foot plain radial drill which is illustrative of a line of three sizes. One of the features of this line of tools is the large numbers of speeds with which they are provided. These vary with the size of the tool, the minimum speed of the 6-foot radial being adapted to driving a 6-inch pipe tap, that of the 5-foot machine to driving a 5-inch tap and of the 4-foot machine, a 4-inch tap. The range, however, is identical on all, the maximum speed on each being 13.63 times the minimum, but, of course, having a different starting point.

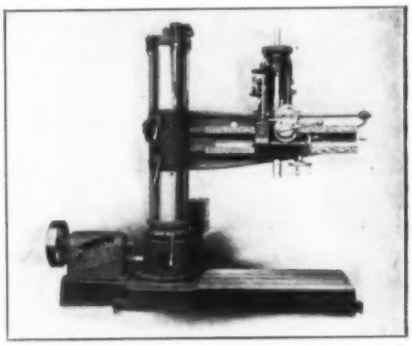
The speeds for the radial shown range from 22.5 to 307 revolutions per minute. The speeds are suitable for drills from 7/16 to ⅞ inch inclusive, rising by sixteenths; from ⅞ to 2¼ inches, by eighths; and from 2¼ to 3½ inches, by quarters.

The speeds are obtained by two levers, one on the head controlling the three back-gear speeds; the other, located on the speed box, controls the eight speeds furnished by that mechanism. The speed box is patterned after the one by the same company described fully at page 361, Vol. 28, Part 2.

There are eight graduations of feed in geometrical progression from 0.007 to 0.064 inch per revolution of the spindle, each of which is instantly available. The tapping mechanism is located on the head, and permits the backing out of taps at any speed with which the machine is provided, regardless of the speed used in driving the tap in. The tapping mechanism is controlled by a lever within easy reach of the operator.

The machine is equipped with a depth gage, which is also convenient for setting the automatic trip. The automatic trip operates at as many different points as there are depths to be drilled at the one setting of the work.

After intermediate tripping the spindle is free to be raised or lowered or traversed its full length without disturbing the dogs; the feed throws out automatically when the spindle reaches the limit of its movement.



A PLAIN RADIAL DRILLER.

This machine is built by the Bickford Drill and Tool Company, Cincinnati, Ohio.

A THREE-SPINDLE DRILL.

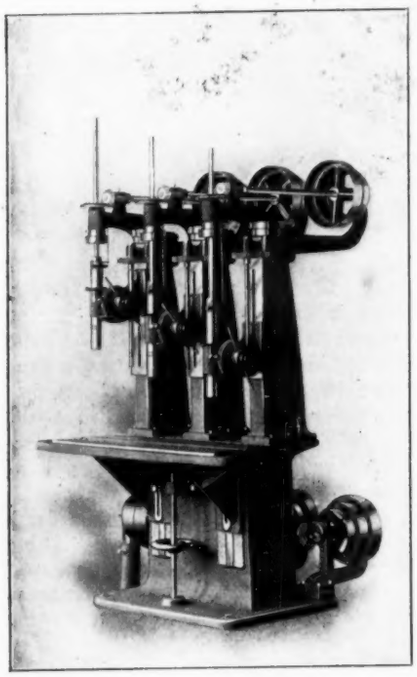
The illustration shows a three-spindle drill of medium capacity with a large range of adjustments.

Each spindle is independent in speed, feed and vertical adjustment, so that the various heads may be set at diverse hights to suit the work or jigs being used.

The spindles have hand and power feeds, automatic and positive stops, and ball thrusts.

The table has an oil groove and is vertically adjustable by means of screw and hand wheel. Each sliding head is clamped in position on the column by a binder.

The countershaft is secured to the base of the machine, the tight and loose pulleys being to the left. The machine will take drills up to ¾ inch diameter. Distance from center of spindle to face of upright 10¼ inches.



A THREE-SPINDLE DRILL.

The maxjmum and minimum distances from the end of the spindle to the top of the table are 27 and 6 inches respectively. Working surface of the table 14x41 inches. The machine weighs 2600 pounds and is built by Foote, Burt & Co., Cleveland, Ohio, U. S. A.

The Technical Publicity Association made of its meeting September 27, at the rooms of the Aldine Club, an editors' night. At the conclusion of a good dinner Thomas Cummerford Martin of the *Electrical World*, as the principal speaker, spoke particularly upon the impending increase of postage rates on second-class mail matter, which he held would be a serious burden upon trade papers and would force many of them out of existence. Messrs. Boardman of the *Railroad Gazette*, Baker of the *Engineering News*, Wright of the *American Railway Journal*, Royce of *Electrical Railway Review*, Gray of the *Electrical Review* and Miller of the AMERICAN MACHINIST discussed the same and other subjects of mutual interest.

A Brazing Shop and Its Work

Some time ago we published an item about "Ferrofix," which is a substance used in brazing, and which makes it quite practicable to braze large castings which may have been broken. The discovery of this material has led to a number of industries of some importance, one of the establishments being located at 196 Eleventh Avenue, New York City, and called The New York Brazing Company. Henry F. Frasse, who was formerly in the machinists' tool and supply business in Cortlandt street, is connected with this company, and is getting in a large variety of broken machinery for repairs. The shop is fitted with an overhead traveling crane for handling heavy weights, and upon the floor at the time of the recent visit of a representative of this journal, there was a New Haven planer 50x50 inches x19 feet, and with a bed about 27 feet long, which had met with an accident in transportation by truck, and had a section about 3 feet long broken out of one side of the bed just forward of the housing. Such a break would, under ordinary conditions, with a planer such as this, which was second hand and of old model, have rendered the machine of no further use except as scrap iron. With the facilities in this establishment, however, which include large surface plates or benches having planed cast-iron tops upon which work can be placed and clamped while fire-brick structures are built up around the broken portion in such a way as to confine the heat of the gas burners used, it is a comparatively simple matter to mend such a break as this and render the machine as strong as before it was broken, and with accuracy scarcely, if at all, impaired. Frames of punch presses, motor frames, automobile cylinders, engine frames and many other similar things heretofore impossible to repair except by patching, and in some cases not at all, are by this method readily made practically as good as new. The value of the process is perhaps especially shown in the case of teeth of large gear wheels which have been broken by some accident, and which are readily replaced and fastened with accuracy.

Personal

George W. Graves has opened an office as architect and engineeer in Room 8, Cleland building, Detroit, Mich.

George W. Fleming, who until recently was with the Williamsport Supply Company, Williamsport, Penn., is engaged by the Vandyck Churchill Company, and is connected with its Pittsburg branch in the Farmers' Bank Building.

C. A. Rossberg, formerly of New Britain, Conn., and for the past three years with the Winchester Repeating Arms Company, of New Haven, is now chief draftsman of the Veeder Manufacturing Company, of Hartford, Conn.

At a meeting of the Association of Accountants and Bookkeepers, of Philadelphia, held September 14, Wesley A. Fink, accountant with the Corliss Engine Company, presented a paper on "Accounting Systems for Jobbing Machine Shops."

F. E. Ross has resigned the position of manager of the Manufacturing Equipment and Engineering Company, of Boston, to take the position of treasurer and general manager of the Boston Tool Company, Cambridge, Mass., a newly incorporated company, which will manufacture dies and build special machinery.

Obituary

George H. Poor, inventor of the Poor air brake, died at Portland, Me., September 28, 61 years old.

James Abercrombie Burden, formerly president of the Burden Iron Company of Troy, N. Y., died of gastritis at his home on Fifth avenue, Sept. 23, aged 74 years. Mr. Burden was born in Troy, and was the eldest son of Henry Burden, who came to this country from Scotland in 1819, settled in Troy, and founded the Burden Iron Company. Like his father, James A. Burden was an inventor, and was well qualified to manage the large manufacturing and other interests left by the former at the time of his death. Mr. Burden went to the Yale Scientific School, and also took a course at the Rensselaer Polytechnic Institute, and then started in to obtain practical experience in the plant at Troy. In 1883 he became president of the Burden Iron Company, and of the Hudson River Iron and Ore Company. He took out in his younger days no less than 18 important patents. He was a member of several engineering and scientific societies, among them the American Society of Mechanical Engineers, of which he was a charter member.

New Publications

"The Management of Electrical Machinery." By Francis B. Crocker and Schuyler S. Wheeler. 223 5x6-inch pages, with 131 illustrations. The D. Van Nostrand Company, New York. Price, $1.

This volume is the sixth revised edition under a new name of "The Practical Management of Dynamos and Motors." The revision has been very complete, new matter on alternating-current generators and motors and on railway motors having been added, and on the other hand matter which has become obsolete has been omitted. The

book is a thoroughly satisfactory manual for those in charge of electrical machinery. It is in no sense a primer, but it assumes its readers to be intelligent men, capable of understanding the machinery which they operate, and addresses them accordingly.

"A Course of Instruction in Elementary Machine Design." By J. D. Hoffman, 103 8½x11-inch pages with numerous illustrations, tables and plates. The Burt-Terry-Wilson Company, Lafayette, Ind.

As befits its purpose as a text book for the students of Purdue University, this book is a compendium rather than a treatise. The student finds the numerous formulas with which he has become acquainted through his study of analytical mechanics adapted for special cases and arranged and grouped for use together with tables of constants and of empirical dimensions of parts which are not capable of analytical treatment. The application of these formulas and data is then shown by taking up the design of various machines. The arrangement is good and the plan of the book leads to great compactness and the covering of a large amount of ground in small space.

Business Items

The Latshaw Pressed Steel and Pulley Company, Pittsburg, Pa., has appointed the Henry J. McCoy Company its distributor for New York City, Chas. E. Ring & Co. for Brooklyn, and R. Gray, Jr., Inc., for Newark, N. J.

Eurich & Tryens, Chester, Penn., will engage in the manufacture of drop-forge dies and forgings. They have completed the equipment of their shop and business will be commenced at once.

The Goldschmidt Thermit Company is about to vacate its present manufacturing premises at 179 Christopher street, New York City, as they are insufficient for the largely increased business. It has bought ground at the corner of Cornelison and Bishop streets, Jersey City, N. J., and has erected there a large and commodious factory building, 165x75 feet, within easy reach of its downtown offices, and intends moving its manufacturing plant to the new location about October 1.

The Boston Tool Company, 207 Bridge St., Cambridge, Mass., has just been incorporated and will make a specialty of manufacturng blanking, drawing, forming and cutting dies, drop-forge dies, jigs, tools and fixtures, do stamping and press work of every description, experimental work and design and build special machinery to order. The officers of the company are Charles C. Camber, president; Frank E. Ross, treasurer and general manager, and Leon P. Alford, secretary.

Manufacturers

The Lester Milk Company, Philadelphia, Pa., will build a three-story addition, which will be used for ice manufacturing.

Fire destroyed the plant of the Hoosier Fence Company, Anderson, Ind. Loss, about $40,000. The plant will be rebuilt.

Henry Disston & Sons, Inc., Philadelphia, Penn., manufacturers of saws, files, tools, etc., will put up a three-story addition.

The Norton Company, Worcester, Mass., manufacturing grinding wheels, etc., will erect an addition to be used as a crushing shop.

Two new buildings will be erected for the Fanner Manufacturing Company, Cleveland, Ohio. This company makes chaplets, brass beds, etc.

The New Home Sewing Machine Company, Orange, Mass., will build an addition to the milling department and a larger shop for box making.

The Paragon Plaster Supply Company, Jamaica, L. I., a new concern, is erecting a $25,000 plant. John J. Bliss, of Jamaica, is general manager.

A new factory for the manufacture of gasolene engines will be built for C. P. & J. Laughlin, Milwaukee, Wis. Two traveling cranes will be installed.

George A. Glenn & Co., Philadelphia, Penn., are estimating on a new pottery for the Monument Pottery Company, Trenton, N. J., to cost $150,000.

The Hudson River Electric Power Company, of Glens Falls, N. Y., will erect a $50,000 building, to be used as a transforming station at Cohoes.

The Northern Malleable Iron Company, St. Paul, Minn., has purchased a site on which a large plant will be erected. Five hundred men will be employed.

The Blood Broom Manufacturing Company has been organized at Fergus Falls, Minn. Capital, $10,000. J. G. Durrell, president; L. S. Blood, manager.

The R. J. Schwab & Sons Company, Milwaukee, Wis., has let contracts for the erection of a machine shop, power house, pattern vault and blacksmith shop.

The Globe Foundry Company, of Port Chester, N. Y., has formed the Globe Foundry Company, of Huntington, W. Va., and will erect a plant at the latter place.

The Hancock Concrete Machine Company is being formed at Lestershire, N. Y., to manufacture a concrete block machine patented by John Hancock, of that place.

Contract has been let for the construction of a $125,000 steel building at Gadsden, Ala., to be used as a power house by the Alabama City, Gadsden and Attalla Railway Company.

The Atlantic Rubber Manufacturing Company has been incorporated at Trenton, N. J., and will erect a plant in Morrisville, Pa. L. J. Buckley, of Glen Ridge, N. J., is president.

The La Crosse (Wis.) Water Power Company have let contracts for the construction of a dam and power-house at Hatfield. Between $1,500,000 and $2,000,000 will be expended.

The Wood Fibre Company has been incorporated with $100,000 capital, and will erect a box factory in Sanborn, N. Y. B. T. Hudson, Frank Stover, of Sanborn, are directors.

The Neptune Avenue Ice Company has been formed at Coney Island, N. Y., with a capital of $100,000. Philip A. Leninger, Lorance Poulson and Herbert A. Freeman, directors.

The Alton Manufacturing Company, whose head office is on Milk street, Boston, Mass., will erect a mill at Alton, R. I., for the manufacture of lace, to replace one burned some years ago.

The American Shoe Findings Company, Whitman, Mass., will erect a large addition to the factory recently purchased at Bingham, Me., and will increase the output of wooden shanks.

The Salt Lake Public Service Company, owner of lighting, heating and power franchises in Salt Lake City, Utah and an electric-lighting franchise in Park City, has filed articles of incorporation. The concern is capitalized at $3,000,000 and will erect a number of new plants and stations. James J. Chambers is president.

Catalogs

Pratt Institute, Brooklyn, N. Y. Booklet describing one-year course in machine construction. Illustrated, 6x9 inches, 112 pages, paper.

John Royle & Sons, Paterson, N. J. Catalog of the Royle-Richards engravers' ruling machines. Illustrated, 6x9 inches, 47 pages, paper.

The Goulds Manufacturing Company, Seneca Falls, N. Y. Booklet describing Goulds efficient power pumps. Illustrated 4x7½ inches, 32 pages, paper.

Technical Supply Company, Scranton, Pa. 1906-1907 catalog and price list of drawing materials, mathematical, scientific and engineering instruments. Illustrated, 6x9 inches, 301 pages, paper.

The Burt Manufacturing Company, Akron, Ohio, will issue October 1, a 64-page catalog describing complete line of oil filters exhaust heads and ventilators and will be glad to send a copy to anyone interested.

Keuffel & Esser Company, 127 Fulton St., New York. Booklet, entitled "The Story of the Autarith," which tells of the origin, development and use of this calculating machine. Illustrated, 4x8 inches, 12 pages, paper.

Edgar T. Ward & Sons, 25 Purchase street, Boston, Mass. Price List F. Cold-rolled strips, bars, sheets and shapes, Dannemora and Capital High-Speed tool steels, fine steel wires. Illustrated, 5½x8 inches, 76 pages, paper.

Stanley-G. I. Electric Manufacturing Company, Pittsfield, Mass. Bulletin 609, superseding Bulletins 25 and 194, devoted to G. I. floor and wall outlet boxes. Circular 786, devoted to the new type K arc lamps. Circular 787, devoted to direct-current cotors and generators.

Miscellaneous Wants

Advertisements will be inserted under this head at 25 cents a line each insertion. Copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded.

Caliper cat. free. E. G. Smith, Columbia, Pa.

Cox Computers, 75 Broad St., New York.

Wire and sheet-metal-working machinery and tools. Emmons Collins, Chicago, Ill.

Will buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

Light, fine machry. to order; models and elec. work specialty. E. O. Chase, Newark, N. J.

Working Drawings—Experimental work. Geo. M. Mayer, M. E., 1131 Monadnock Block, Chicago, Ill.

Runnerless slide rules. New method of operating. F. F. Nickel, 27 Winans St., East Orange, N. J.

Tools, dies and special machinery built by contract. Chas. Crabb Co., 635 Kent avenue, Brooklyn, N. Y.

Gas engines designed to order. Marine and automobile work a specialty. H. L. Towle, 150 Nassau street, New York

Special machinery accurately built. Screw machine and turret-lathe work solicited. Robt. J. Emory & Co., Newark, N. J.

Special machinery to order. Catalog of small engines and boilers and engine castings, 10c. Sipp Elec. & Mach. Co., Paterson, N. J.

All patterns, tools and jigs for my patternmakers vise for $25. Also patterns for a small drill for $20. J. L. Gard, Denver, Colo.

Wanted — Special screw-machine work up to 1 inch diameter; press work up to 5 inches diameter. Inventor's Mfg. Co., 134 Eliot St., Boston, Mass.

Work wanted for a Cleveland automatic lathe; handles 2 in. and under. The Earle Gear and Machine Co., 141 Oxford street, Philadelphia, Pa.

We have a modern machine shop in charge of skilled mechanics. We make special machinery, tools, dies, punches, sheet metal stampings, model and experimental work. Wolverine Manufacturing Co., Pittsburg, Pa.

Draftsmen — Architectural, mechanical, structural, electrical, are needed for responsible positions; salaries $900-$2500. Write us today stating experience and position desired. Offices in 12 cities, Hapgood's, 205 Broadway, N. Y.

Gas-engine expert invites correspondence; at present chief draftsman with a well known concern; has had wide range of experience on medium size and large gas engines, suction and pressure gas producers; patentee of several successful improvemnets. Box 115, AMERICAN MACHINIST.

Tool catalog No. 22, 950 pages bound in cloth. Greatest small-tool catalog ever published. Will be sent post-paid on receipt of $1. Money paid for catalog refunded with first purchase amounting to $10 or over. Book costs you nothing if you become a customer. Montgomery & Co., 109 Fulton street, New York City.

For Sale

For Sale—Foundry, wood and iron machine shop. Box 74, Albion, N. Y.

For Sale—Small gasolene (marine) engine plant in central New York; rushed with orders. Write for particulars. Address S. K. Gibbs, Schenectady, N. Y.

A 20-h.p. gas engine for sale cheap; has been used only 18 months and in good running order; a bargain. The Lapointe Machine Tool Company, Boston, Mass.

$50,000 buys plant, manufacturing own patented machines, in operation throughout the country, including patents, machinery, factory, tools, jigs good will; 15 miles from New York City; doing good business. Box 958, AMERICAN MACHINIST.

Business Opportunities

Old machine and tool company wants mechanical and office man. Must invest $5000 in business. Always made money. Expanding. Box 142, AMERICAN MACHINIST.

Reenforced concrete company, always 8 per cent. dividend paying, wants good business man either as treasurer or secretary. Must invest in treasury stock. High standing. Can also use technical man. Box 141, AMERICAN MACHINIST.

We can build machinery for quick delivery. A shop building machine tools wishes to take contracts for the construction of machinery or anything that can be produced in a foundry and machine shop. Send drawings and specifications and estimates will be made with guarantee of quick delivery. We can refer to a standard line of tools now on the market as to the quality of workmanship. Box 75, AMERICAN MACHINIST.

Machine shop and foundry for sale—This plant is nearly new; located in good city in northern Ohio; machine shop has 15-ton electric crane and 45 machine tools, including 5 planers (84"x16' Pond with 3 heads and smaller), 10' boring and turning mill, 8 lathes, 2 radial drills, etc.; tools are driven in groups by three motors. Foundry has 25-ton electric crane, No. 6 Whiting cupola, air furnace, etc. Plant now in full operation. Full particulars on application. We will make a very low price on this property to insure quick sale. William A. Reade & Company, 402 Chamber of Commerce Building, Cleveland, Ohio.

Wants

Situations and help advertisements only inserted under this head. Rate 25 cents a line for each insertion. About six words make a line. No advertisements under two lines accepted, and no advertisements abbreviated. The cash and copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. Original letters of recommendation or other papers of value should not be enclosed to unknown correspondents. Only bona fide situation want or help want advertisements inserted under this heading. Agency advertisements must be placed under Miscellaneous Wants.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

CONNECTICUT.

Superintendent of an extensive manufacturing plant desires to make a change; accustomed to the latest and best machine-shop methods and practice; capable of organizing and handling a machinery plant in all its branches; a designer of special and automatic machinery, tools, jigs and fixtures for the rapid and economical production of fine and medium heavy interchangeable work. Box 86, AMERICAN MACHINIST.

ILLINOIS.

Assistant general manager, technical graduate, desires position with engine or machinery manufacturing plant. Box 108, AM. M.

A capable designer familiar with machine tools, special machinery for manufacturing purposes, presses, dies, jigs and fixtures, etc., wants responsible position either at designing or in charge. Box 139, AMERICAN MACH.

MASSACHUSETTS.

Steel measuring tapes and rules—Position wanted by an expert, late with the Starrett Co.; etcher also on ivory, bone, pearl, etc. John Campbell, Athol, Mass.

MICHIGAN.

Machine shop foreman, 30, broad gage, inventive ability, able executive, thoroughly up to date, modern shop practice, automobile or light interchangeable machines, references. Box 140, AMERICAN MACHINIST.

Wanted—Responsible position by man of wide experience in mechanical and manufacturing lines; present position, superintendent of factory employing from 350 to 400 men; best of references. Address Box 35, AM. M.

NEW JERSEY.

Mechanical draftsman wishes position. Address Box 132, AMERICAN MACHINIST.

M. E. wants position; experience on engines, pumps, etc., good draftsman, executive ability, best of references. Box 144, AMERICAN MACHINIST.

Young man (22), two years' experience as tracer, knows also a little about detailing and patterns, wishes position around New York City at $13.50 per week. Box 127, AM. MACH.

Mechanic, age 31, with 10 years' experience on tools, special machinery, experimental work, instrument work, metal patterns and general manufacturing; would like responsible position as assistant superintendent, master mechanic, foreman, systematizer or confidential position as representative in any business along mechanical lines; best of references as to ability and reliability. Box 138, AM. MACH.

NEW YORK.

Foreman wants position; all-around man and expert lathe hand. Box 94, AMER. MACH.

Mechanical electrical draftsman, 8 years' experience; technical graduate. Box 131, AMERICAN MACHINIST.

Expert systematizer able to devise his own system, wishes position. Good superintendent or manager. Box 119, AMER. MACH.

Foreman—young man, first-class machinist, toolmaker, accustomed to modern machine shop practice, also expert on steel type—wants good position. Box 128. AM. MACH.

General foreman—successful in producing first-class work at satisfactory cost, varied experience in building high-grade machinery, practical mechanic—desires change; $36 a week to start. Box 954, AMER. MACHINIST.

Mechanical draftsman and designer—26, college graduated, with 5 years' practical experience on general work and special machinery—wants change; at present employed; A-1 references; salary $20 per week. Box 134, AMERICAN MACHINIST.

Position wanted, Middle or Western States. Experienced as general foreman, foreman of toolrooms and manufacturing plants; successfully producing small and medium special machinery, machine tools, typewriters, etc. Age 32. Salary $2000. Box 143, AM. MACH.

OHIO.

Works superintendent, now employed, wishes to make a change; 15 years' experience; good executive; can produce results. H. L., Box 133, AMERICAN MACHINIST.

Manufacturing department foreman, now with up-to-date firm, desires to become associated with firm in need of his services and experience on interchangeable work, labor-saving tools, systems and men; 30 years of age. Box 130, AMERICAN MACHINIST.

PENNSYLVANIA.

Machine-shop foreman desires a change; wide experience on engines, mill work and repairs; reliable, energetic and resourceful; can appreciate opportunity to advance. Box 137, AMERICAN MACHINIST.

Mechanical designer, with executive ability, 30, German university graduate, six years' experience on general line, good mathematician; last position, shop office; A-1 reference. Box 136, AMERICAN MACHINIST.

Designing draftsman wishes to change; technical graduate, eight years' experience on gas engines and automobiles; practical and inventive man, familiar with modern manufacturing requirements. Box 129, AM. MACH.

RHODE ISLAND.

Wanted—Position as superintendent of machine shops, accurate, heavy, interchangeable work preferred; first-class reference. 45 years old, married, sober, well and strong and means business. Address Box 120, AMERICAN MACHINIST.

VIRGINIA.

Position wanted by a master machinist with a progressive concern in need of a repair expert; wide experience in the molding, pattern, forging and machine shops enables me to take entire charge of up-keep of engines, boilers, pumps, piping and tools, run in connection with a large manufacturing plant; minimum salary $1600 per annum. Box 135, AMERICAN MACHINIST.

Help Wanted

Classification indicates present address of advertiser, nothing else.

CALIFORNIA.

Foreman for old established western gas-engine plant manufacturing stationary, marine and hoisting engines. Must be a good organizer, able to handle men, up to date and able to show results; a man of experience with good references. The right man can secure a permanent position with chance to advance soon. Give full particulars. Box 121, AMERICAN MACHINIST.

CANADA.

Wanted—Experienced draftsmen on jigs, fixtures and tools. Give age, experience and wages expected. Ross Rifle Co., Quebec, Canada.

Wanted—One first-class diemaker experienced in making armature and other dies for electric motors; references required. Box 105 AMERICAN MACHINIST.

Wanted—Good executive to take charge of order and shipping departments of large electrical factory in Canada. Apply stating experience, references, age, salary wanted, to Box 50, AMERICAN MACHINIST.

CONNECTICUT.

Wanted—First-class operator on Jones & Lamson turret lathe; also one first-class all-around machinist. The New Machine Co., Danbury, Conn.

Wanted—Tool makers, die sinkers, drop forgers and men familiar with grinding machines. Apply to D. P. Beckwith, Pope Manufacturing Company, Hartford, Conn.

Wanted—A man to make tools and take charge of department for the manufacture of piano hardware, to start with a small force and develop this branch of our business. The right man would have an opportunity to become a member of the firm. Give age, nationality and experience. Address Box 123. AMERICAN MACHINIST.

DELAWARE.

First-class draftsman wanted; one having experience in machine tools preferred. Apply, stating experience and salary expected, to Betts Machine Co., Wilmington, Del.

INDIANA.

Wanted—An up-to-date machine-shop foreman; one who has made a success and can give good references. Box 126, AMER. MACH.

MASSACHUSETTS.

Wanted — First-class toolmakers, milling machine, floor and vise hands on high-grade medium weight machinery; good pay and permanent positions to competent workmen. Box 85, AMERICAN MACHINIST.

Wanted—An experienced operator on Gould & Eberhardt gear cutters on heavy work; a man who knows how, and can tell how, to cut gears; man with theoretical and practical knowledge preferred. Box 32, AMER. MACH.

A growing machine shop, wishing to add to its line of work, invites correspondence with a man sufficiently expert in some profitable line (machine tools preferred) to introduce its manufacture, and later to attend to the sales and installation work. To such a man a liberal salary will be paid on demonstration of ability to make good. Box 98, AM. MACH.

Wanted—Two first-class machinists; must be capable of doing light, fine machine work; no common, rough workmen will answer. For competent men we can offer permanent positions; light, pleasant shop, 20 miles from Boston. In answering, state age, experience and wages expected. Replies will be held strictly confidential. Box 112, AMER. MACH.

MICHIGAN.

Wish to correspond with two draftsmen having experience of at least four years; must be familiar with boiler settings and general boiler work. Address "F. F.," Box 103, AMERICAN MACHINIST.

Wanted—A man capable of designing sawmill machinery and laying out complete installations. Must have experience of at least eight or ten years and be thoroughly practical. Address "G.," Box 102, AMER. MACH.

Wanted—Applications from first-class toolmakers, machinists and assemblers on automo-

bile motors. We are constantly increasing our plant and want to hear from first-class men only; new plant; well situated; pleasant surroundings for family men; best schools in the State. Address Continental Motor Mfg. Co., Muskegon, Mich.

Wanted—Experienced man to take charge of drafting room, employing about six men, with old established and progressive firm; one capable of checking drawings and directing the work; experience in automobile or gasolene work desirable; permanent position to right man; references required. Box 43, AMERICAN MACHINIST.

NEW JERSEY.

Wanted—Mechanical draftsmen; location, Newark, N. J.; state experience and salary expected. Box 122, AMERICAN MACHINIST.

Several first-class tool and diemakers accustomed to high-grade work; steady employment and good wages to competent men. Sloan & Chace Mfg. Co., Sixth avenue and Thirteenth street, Newark, N. J.

We are increasing our toolmaking department and solicit applications from toolmakers and machinists who are experienced on fine and complicated work. Apply to Victor Talking Machine Co., Camden, N. J.

We have increased our plant and desire floor and vise hands for day work and lathe hands for night work. Good pay and steady work to good men. Address or apply at Pond Machine Tool Co., Plainfield, N. J.

NEW YORK.

Wanted—A first-class case hardener. Apply with references to R. Hoe & Co., 2 Sheriff street, New York.

Wanted—Two experienced draftsmen, familiar with automobile construction. Address Box 117, AMERICAN MACHINIST.

Wanted—Experienced men on general tool work; steady positions for the right men. Remington Typewriter Factory, Ilion, N. Y.

Wanted — Experienced draftsmen, toolmakers and machinists. Give age, references and wages expected. Remington Arms Co., Ilion, N. Y.

Mechanical draftsmen wanted for detail work; ability in machine design not necessary; state experience and age. Address Box 41, AMERICAN MACHINIST.

Wanted—We have openings for several competent young machinists on machine tools and erecting floor. Watertown Engine Company, Watertown, N. Y.

Wanted, foreman—A brass manufacturing firm wants a first-class experienced foreman familiar with line of steam appliances. Address "Manufacturing Foreman," Box 95, AMERICAN MACHINIST.

Wanted—Foreman familiar with fine work on small punches, dies and jigs; must be competent to handle help and devise methods for economical production; permanent employment to the right party. Box 118, AM. MACH.

Wanted—Draftsmen experienced on tools for the manufacture of light interchangeable parts; also a rapid professional tracer; position permanent to capable men; location, small town pleasantly situated. Box 101, AMERICAN MACHINIST.

Toolmakers—A finely equipped shop, pleasantly located, about two hours from New York City, is in need of a few first-class toolmakers and universal milling machine hands; also ambitious young men who have had some experience on tool work and would appreciate an opportunity for all-around experience; pay according to ability—the higher the better; 54 hours per week, Saturday half-holiday the year round. Write, giving full experience, S. L. D., Box 66, AMERICAN MACHINIST.

OHIO.

Our growing business constantly requires additional machinists. We build lathes, planers, shapers, drilling machines; good opportunity for machinists. The American Tool Works Co., Cincinnati.

The National Metal Trades Association can place a few first-class toolmakers, patternmakers and blacksmiths. Positions will be guaranteed as steady and at highest prevailing rate of wages. This is an opportunity for first-class men to secure one of the N. M. T. A. certificates of recommendation. For further particulars address The National Metal Trades Association, Cincinnati, O.

PENNSYLVANIA.

Wanted—Competent machine hands. The Blaisdell Machinery Co., Bradford, Pa.

Wanted — Machinist, expert hardener, to take charge of hardening tool steel and case-hardening machinery steel; steady position to the right man; Philadelphia shop. Box 124, AMERICAN MACHINIST.

The Monotype Company maintains a free school for training young machinists to operate its type casting and composing machines. The demand for monotype operators is so great that it receives more applications for places in its school than can be filled. In making selections these qualifications carry most weight: Character, common sense, experience with automatic machinery (or) printing-office experience, or type-foundry experience. Full particulars will be furnished to inquirers who furnish full particulars about themselves. Lanston Monotype Machine Co., 1231 Callowhill St., Philadelphia, Pa.

RHODE ISLAND.

Toolmakers wanted—First-class workmen on jig and fixture work for light high-grade machinery. Permanent employment to competent workmen. Apply to the Taft-Peirce Mfg. Co., Woonsocket, R. I.

Wanted—First-class mechanical draftsman, used to small automatic machines; man with experience on composing machines preferred; steady employment for right party; state in full experience and salary expected; unless capable, do not reply. Box 125, AM. MACH.

WISCONSIN.

Wanted—Machinists, lathe, planer, shaper and drill-press hands, vise, floor and handy men. Apply A. B. C., Box 96, AMER. MACH.

Wanted — Draftsman with experience in electrical drafting room; must be capable of laying out either direct-current or alternating-current machinery, also of checking detail drawings; state age, nationality, experience and salary wanted. National Brake & Electric Company, Milwaukee, Wis.

Large concern building excavating and railway machinery wants to correspond with first-class mechanical draftsmen with view to filling future vacancies as they occur; wants men now employed; give full experience and reason for changing; shop experience great advantage; all letters acknowledged and held confidential. Box 919, AMERICAN MACHINIST.

The Fairbanks-Morse Manufacturing Company, at Beloit, Wis., is constantly increasing its works and can use a large number of first-class mechanics, such as machinists, molders, patternmakers and erecting engineers, to work on gas and gasolene engines, steam pumps and hydraulic machinery. Address Fairbanks-Morse Mfg. Company, Beloit, Wisconsin.

FOREIGN.

General superintendent (American) for large automobile plant in Paris; must be thoroughly up-to-date for quick interchangeable work at lowest cost; the best is not too good; proved capacity of greater importance and will be considered before salary; knowledge of French language useful, but capacity for output the principal point. Reply, giving fullest particulars, to J. Ryan, 78 Avenue de la Grand Armée, Paris, France.

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Estep & Dolan, Sandwich, Ill.
Wallace Supply Co., Chicago, Ill.

"Whitney" Chains in the GLIDDEN Contest were used more extensively than all others combined and made their customary records for efficiency.

Patented Patented

The Whitney Mfg. Co., Springfield, Mass., August 10, 1906.

Gentlemen:— In reply to yours of the 9th, we are pleased to advise you that we used Whitney chains on both our pleasure and commercial vehicles in the Glidden Tour, both of which finished with perfect scores, having no trouble whatever with chains, and without the slightest care or attention the same finished the trip in perfect order.

Yours very truly,
KNOX AUTOMOBILE COMPANY.

The Whitney Mfg. Co., New York Office, August 22, 1906.

Gentlemen:— I beg to acknowledge receipt of your favor of the 21st inst., with reference to the Whitney chains which were used on the Mark 47 Columbia Car that I drove in the Glidden Tour.

Replying would say that we experienced no difficulty or trouble at all with the chains and the test was severe indeed. Yours very truly,
ELECTRIC VEHICLE COMPANY.

The Whitney Mfg. Co., Buffalo, N. Y., September 4, 1906.

Gentlemen:— The two Thomas cars which competed in the Glidden Tour, one finishing with a perfect score and the other with two points against it on account of a technicality, were both equipped with Whitney chains. These chains were entirely satisfactory and we shall continue to use them for 1907 as we have in the past. Very truly yours,
E. R. THOMAS MOTOR CO.

The Whitney Mfg. Co., Cleveland, Ohio, August 15, 1906.

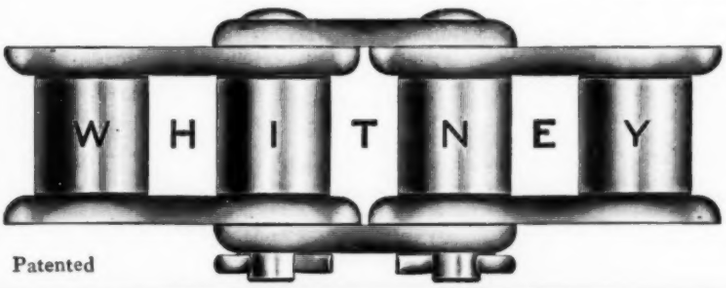
Gentlemen:— Replying to yours of the 13th, beg to say that neither of our two cars entered in the Glidden Tour experienced the slightest chain trouble, nor did our two 1907 cars which we drove from Cleveland to Bretton Woods in four days, and later won from all comers in all three events in the Crawford Notch Hill Climb. We beg to say that we are running the same chains on these cars at present. Very truly yours,
THE F. B. STEARNS CO.

The Whitney Mfg. Co., Lansing, Mich., August 15, 1906.

Gentlemen:— Referring to your letter of Aug. 13, wish to state that we used the Whitney Roller chain on the REO Car in the Glidden Contest and it proved very satisfactory, having no trouble whatever from that source. Very truly yours,
REO MOTOR CAR COMPANY.

The Whitney Mfg. Co., Hagerstown, Md., August 15, 1906.

Gentlemen:— Answering your inquiry of the 13th as to whether we experienced any trouble with the chains on our Model "C" touring car, which was sent through the Glidden Tour, take pleasure in stating that the chains gave excellent service and that no trouble whatever was experienced throughout the run. Yours truly,
CRAWFORD AUTOMOBILE COMPANY.



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National-Acme Mfg. Co., Cleveland, O.

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Cleveland Cap Screw Co., Cleveland, O.
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Sames, C. M., Jersey City, N. J.
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United Engineering & Fdry Co., Pittsburg, Pa.

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Steffey Mfg. Co., Philadelphia, Pa.

Castings, Steel
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Farrel Fdry. & Mach. Co., Ansonia, Conn.
Kent & Co., Edwin R., Chicago, Ill.

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Clark Cast Steel Cement Co., Shelton, Conn.

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Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
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Pratt & Whitney Co., Hartford, Conn.
Woodward & Powell Planer Co. Worcester, Mass.

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Hammacher, Schlemmer & Co., New York.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Chucking Machines
American Tool Works Co., Cincinnati, O.
Brown & Sharpe Mfg. Co., Providence, R. I.
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Niles-Bement-Pond Co., New York.
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Standard Tool Co., Cleveland, O.
Trump Bros. Mach. Co., Wilmington, Del.
Westcott Chuck Co., Oneida, N. Y.
Whitney Mfg. Co., Hartford, Ct.
Whiton Mach. Co., D. E., New London, Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.

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Gisholt Mach. Co., Madison, Wis.
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Horton & Son Co., E., Windsor Locks, Conn.
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Westcott Chuck Co., Oneida, N. Y.
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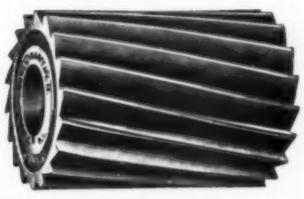

Compressors, Gas
Ingersoll-Rand Co., New York.

Condensers
Stanley-G. I. Electric Mfg. Co., Pittsfield, Mass.

Conduit, Interior
Sprague Electric Co., New York.

Cones, Friction
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Pawling & Harnischfeger, Milwaukee, Wis.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
United Engineering & Fdry. Co., Pittsburg, Pa.
Vandyck Churchill Co., New York.
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Paxson Co., J. W., Phila., Pa.
Stevens, F. B., Detroit, Mich.

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Winkley Co., Detroit, Mich.

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Becker-Brainard Milling Mach. Co., Hyde Park, Mass.
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Cleveland Twist Drill Co., Cleveland, O.
Hardinge Bros., Chicago, Ill.
Ingersoll Milling Mach. Co., Rockford, Ill.
International High Speed Steel Co., New York.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, Jno. M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.
Union Twist Drill Co., Athol, Mass.
Whitney Mfg. Co., Hartford, Ct.

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Brown & Sharpe Mfg. Co., Providence, R. I.
Burr & Sons, Jno. T., Brooklyn, N. Y.
Davis Machine Co., W. P., Rochester, N. Y.
Fawcus Mach. Co. Pittsburg, Pa.
Hill, Clarke & Co., Boston, Mass.
Huribut-Rogers Mach. Co., South Sudbury, Mass.
Newton Machine Tool Works, Philadelphia, Pa.
Nutter, Barnes & Co., Boston, Mass.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Vandyck Churchill Co., New York.

Cutting-Off Tools
Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Fitchburg Machine Works, Fitchburg, Mass.
O. K. Tool Holder Co., Shelton, Conn.
Pratt & Whitney Co., Hartford, Conn.
Western Tool & Mfg. Co., Springfield, O.

Diamond Tools
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Dickinson, Thos. L., New York.

Dies, Sheet Metal
American Tube & Stamping Co., Bridgeport, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Boston Tool Co., Cambridge, Mass.
Globe Machine & Stamping Co., Cleveland, O.
Kent & Co., Edwin R., Chicago, Ill.
Niagara Machine & Tool Works, Buffalo, N. Y.
Toledo Mach. & Tool Co., Toledo, Ohio.

Dies, Sub-Press
Risdon, S. A., Waterbury, Conn.
Waltham Machine Works, Waltham, Mass.

Dies, Threading, Opening
Errington, F. A., New York.
Geometric Tool Co., New Haven, Conn.
Jones & Lamson Mach. Co., Springfield, Vt.
Modern Tool Co., Erie, Pa.
Pratt & Whitney Co., Hartford, Conn.
Scott & Sons Co., Medford, Mass.

Dowel Pins
Winkley Co., Hartford, Conn.

Drawing Boards and Tables
Keuffel & Esser Co., New York
Obermayer Co., S., Cincinnati, O.
Rich, J. & G., Philadelphia, Pa.

Drawing Materials
Keuffel & Esser Co., New York
Rich, J. & G., Philadelphia, Pa.
Soltmann, E. G., New York.
Technical Supply Co., Scranton, Pa.

Drafting Machines
Universal Drafting Mach. Co., Cleveland, O.

Drift Bolt Drivers
Ingersoll-Rand Co., New York.

Drilling Machines, Bench
American Watch Tool Co., Waltham, Mass.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Boynton & Plummer, Worcester, Mass.
Dwight Slate Machine Co., Hartford, Conn.
Goodell-Pratt Co., Greenfield, Mass.
Ingersoll-Rand Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentice Bros. Co., Worcester, Mass.

Drilling Machines, Boiler
American Tool Wks. Co., Cin., O.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bickford Drill & Tool Co., Cincinnati, O.
Boynton & Plummer, Worcester, Mass.
Foote, Burt & Co., Cleveland, O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.

Drilling Machines, Multiple Spindle
American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Baush Mach. Tool Co., Springfield, Mass.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bickford Drill & Tool Co., Cincinnati, O.
Fenn Mach. Co., Hartford, Conn.
Foote, Burt & Co., Cleveland, O.

Drilling Machines, Multiple Spindle —*Continued.*
Fosdick Mach. Tool Co., Cin., O.
Hardinge Bros., Chicago, Ill.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Boston, Mass.
Marshall & Huschart Machry. Co., Chicago, Ill.
McCabe, J. J., New York.
Moline Tool Co., Moline, Ill.
National Machine Co., Hartford, Conn.
Newton Mach. Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Slate Machine Co., Dwight, Hartford, Conn.

Drilling Machines, Portable
Cincinnati Elec. Tool Co., Cin., O.
Coates Clipper Mfg. Co., Worcester, Mass.
Gem Mfg. Co., Chicago, Ill.
Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
Stow Mfg. Co., Binghamton, N. Y.
U. S. Electrical Tool Co., Cincinnati, O.

Drilling Machines, Radial
American Tool Wks. Co., Cin., O.
Baush Mach Tool Co., Springfield, Mass.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Bickford Drill & Tool Co., Cincinnati, O.
Detrick & Harvey Mach. Co., Baltimore, Md.
Dreses Mach. Tool Co., Cin., O.
Fairbanks Co., New York.
Fitchburg Machine Works, Fitchburg, Mass.
Foote, Burt & Co., Cleveland, O.
Fosdick Mach. Tool Co., Cin., O.
Gang Co., Wm. E., Cincinnati, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hill, Clarke & Co., Boston, Mass.
Marshall & Huschart Mach. Co., Chicago, Ill.
McCabe, J. J., New York.
Morris Fdry. Co., Jno. B., Cincinnati, O.
Mueller Mach. Tool Co., Cin., O.
Niles-Bement-Pond Co., New York.
Prentice Bros. Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Ridgway Mach. Tool Co., Ridgway, Pa.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.

Drilling Machines, Turret
National Separator & Machine Co., Concord, N. H.
Niles-Bement-Pond Co., New York.

Drilling Machines, Upright
American Tool Wks. Co. Cin., O.
Baker Bros., Toledo, O.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Boynton & Plummer, Worcester, Mass.
Burke Machinery Co., Cleveland, Ohio.
Cincinnati Mach. Tool Co., Cincinnati, O.
Davis Machine Co., W. P., Rochester, N. Y.
Fairbanks Co., New York.
Fenn Mach. Co., Hartford, Conn.
Fosdick Mach. Tool Co., Cincinnati, O.
Foote, Burt & Co., Cleveland, O.
Gould & Eberhardt.Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Boston, Mass.
Hoefer Mfg. Co., Freeport, Ill.
Knecht Bros. Co., Cincinnati, O.
Marshall & Huschart Mach. Co., Chicago, Ill.
Mechanics Machine Co., Rockford, Ill.
McCabe, J. J., New York.
Morse Twist Drill & Mach. Co., New Bedford, Mass.

SPIRAL GEARS—I

How to Make the Calculations and Cut the Gears—Formulas Gathered from Various Sources

BY H. B. McCABE

Having had occasion to give some instruction in spiral gear cutting in the night classes of the Lewis Institute School of Engineering, led me to select from different sources a set of formulas and arrange them as here given, with the idea that they will cover all cases and, along with the accompanying examples and instructions, be all that is necessary for the complete task of making the calculations and cutting the gears on the universal milling machine.

No attempt has been made to present the course of reasoning by which the formulas were derived. They are all from reliable sources and have been tried out and for practical results it is not necessary to go further than to show by means of a few practical examples how they may be used. To intelligently use the formulas, however, a clear understanding of the deeper and more theoretical phase of the subject is a great advantage although not absolutely necessary. A series of articles by F. A. Halsey at pages 1261, 1284 and 1309 AMERICAN MACHINIST Vol. 24, makes the whole matter very plain indeed. A reprint of these articles along with a treatise on worm gearing by the same author is obtainable in book form,* and is to be commended to any one desiring a foundational knowledge of these things.

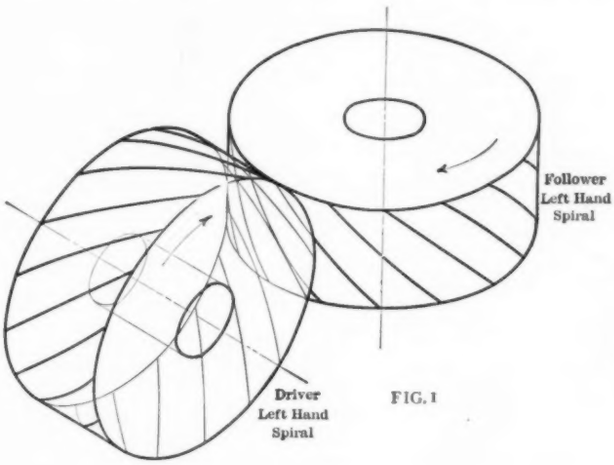


FIG. 1

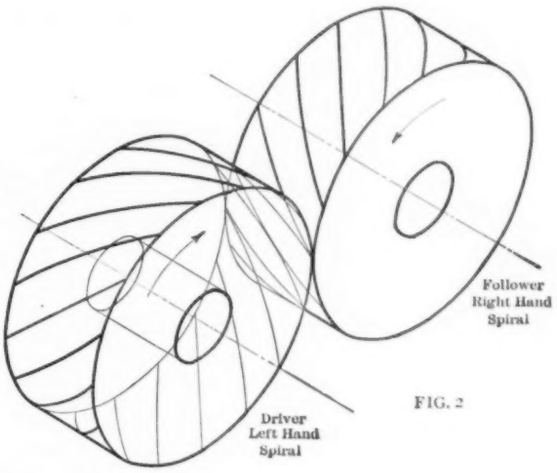


FIG. 2

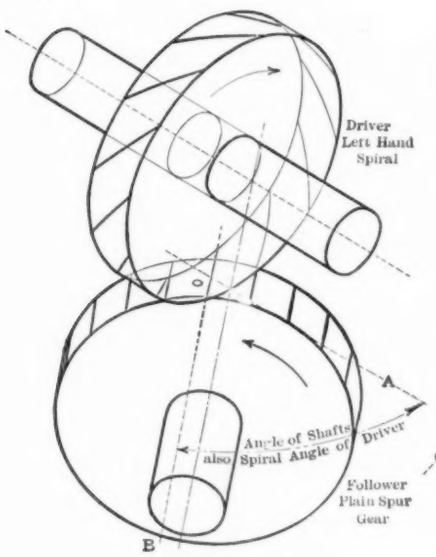


FIG. 3

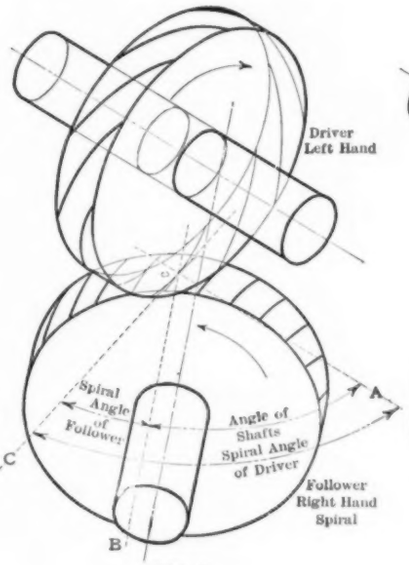


FIG. 4

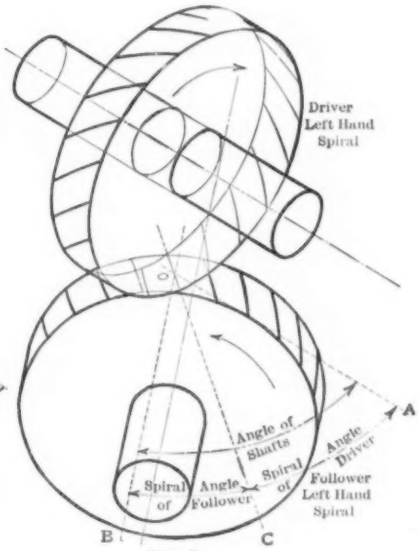


FIG. 5

GEARS OF THE SAME AND OF OPPOSITE HANDS.

Before going into the matter of calculations it may be well to direct the readers to a careful consideration of the accompanying perspective sketches Figs. 1 to 5, inclusive, in which the driving gear of each pair is shown as if transparent, the teeth being represented by lines. Fig. 1 shows a pair of gears on shafts at right angles and Fig. 2 a pair on parallel shafts. Note that in Fig. 1 both spirals are left hand while in Fig. 2 one is left and the other right hand; that is, in the first case they are the same hand and in the second case they are opposite hands. (The word hand as here used has the same significance as in the case of threads.) It is evident that these are two fixed conditions for shafts respectively at 90 degrees and parallel.

Now when the shafts are at any angle between 90 degrees and 0 degrees either of these conditions may exist; that is, the spirals may be both the same hand or they may be opposite hands. This may be made plain by observing carefully Figs. 3, 4 and 5, in which the shafts are at an acute angle, all conditions in the three views being exactly alike except that the teeth are at different spiral angles in each. (By spiral angle is meant the angle a

*No. 116 of Van Nostrand's Science Series.

tangent to the spiral makes with a line parallel to the shaft.) Note that in Fig. 3 the spiral angle of the driver is the same as the angle of the shafts which makes the follower a plain spur gear. Also note that the spiral of the driver is left hand. Now letting the spiral of the driver remain left hand, but increasing its angle a little we have the condition of

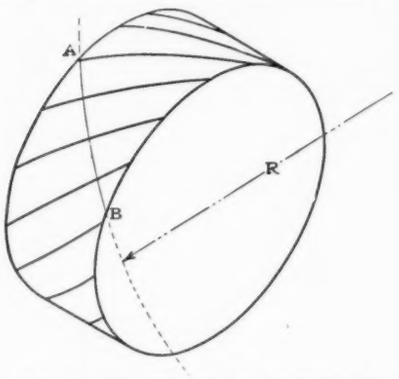


FIG. 6. THE SELECTION OF THE CUTTER.

Fig. 4. By decreasing it a little we have the condition in Fig. 5, making in the first case the spirals opposite hands and in the second case the spirals the same hand.

The lines $O A$ and $O B$ in these figures are drawn parallel to the shafts and the line $O C$ is drawn tangent to the spiral of the teeth and makes with $O A$ and $O B$ respectively the spiral angles of the driver and of the follower. Note that in Fig. 5 the angle of the shafts $A O B$ equals the spiral angles $A O C + B O C$ and in Fig. 4 the same angle $A O B$ equals $A O C - B O C$.

RELATION OF SHAFT- AND SPIRAL-ANGLES.

The following general rules are now evident:

1. When the spirals are the same hand the angle of the shafts is the sum of the spiral angles.

2. When the spirals are opposite hands the angle of the shafts is the difference of the spiral angles.

3. When the spiral angle of one gear is the same as the angle of the shafts the spiral angle of the other will be zero, making it a plain spur gear.

4. When the shafts are at right angles the spirals must both be the same hand.

5. When the shafts are parallel the spirals must be opposite hands.

6. When the shafts are at any acute angle the spirals may be either the same hand or opposite hands.

It is of course understood that spiral gears may be cut with the standard cutters used for spur gears and it is to accommodate these that our conditions must to a large extent be arranged, and our calculations will not be so simple as they would be if we were to make a special cutter for each case. It is well known that involute cutters of the same pitch are made of different shapes for different numbers of teeth and are designated by numbers from 1 to 8, each number of cutter covering a range between certain numbers of teeth. Brown & Sharpe's catalog contains, among many other useful data on gear cutting, a table showing that a No. 1 cutter is for wheels of 135 teeth and upward, a No. 2 cutter is for wheels of 55 to 134 teeth, and so on.

THE NUMBER OF THE CUTTER.

In cutting spur gears we select by this table a cutter for the actual number of teeth in the gear, but in cutting spiral gears we must select a cutter for a different number, which is found by formula (15). This is from Grant's treatise on gears. I have seen other ways of finding this number described, but they will not give the same result, and I think their correctness questionable.

The nature of the result the formula gives may be made clear by Fig. 6, in which $A B$ is a spiral line assumed to be drawn on a pitch cylinder normal to the teeth. The line R extended is the radius of the arc of a circle nearest to coincidence with $A B$. It is the number of teeth in a spur gear of this radius for which we must select the cutter to cut the spiral gear, and this number of teeth is the result the formula gives. The spiral line $A B$ is known as the normal helix:

SPECIAL GEAR FORMULAS.

Notation.

P = diametral pitch of cutter.
c = distance between centers of gears.
d_1 = pitch diameter of driver.
d_2 = pitch diameter of follower.
r_1 = revolutions per minute of driver.
r_2 = revolutions per minute of follower.

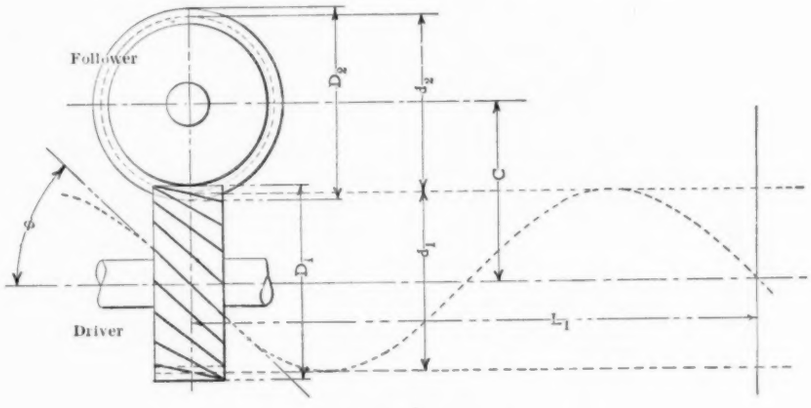


FIG. 7. THE NOTATION.

n_1 = number of teeth in driver.
n_2 = number of teeth in follower.
Θ = spiral angle of teeth in driver.
ϕ = spiral angle of teeth in follower.
L_1 = lead of spiral of driver in inches per turn.
L_2 = lead of spiral of follower in inches per turn.
D_1 = outside diameter of driver.
D_2 = outside diameter of follower.
N_1 = number of teeth for which to select cutter for driver.
N_2 = number of teeth for which to select cutter for follower.
π = 3.1416.

Formulas.

$$n_1 = d_1 P \cos \Theta \quad (1)$$

$$n_2 = d_2 P \cos \phi \quad (2)$$

$$d_1 = \frac{n_1 \sec \Theta}{P} \quad (3)$$

$$d_2 = \frac{n_2 \sec \phi}{P} \quad (4)$$

$$c = \frac{d_1 + d_2}{2} \quad (5)$$

$$c = \frac{n_1 \sec \Theta + n_2 \sec \phi}{2 P} \quad (6)$$

$$d_1 = \frac{2 c}{\frac{r_1}{r_2} \cot \Theta + 1} \quad (7)$$

$$d_1 = \frac{2 c}{\frac{r_1}{r_2} \frac{\cos \Theta}{\cos \phi} + 1} \quad (7a)$$

$$d = 2 c - d_1 \quad (8)$$

$$\frac{r_2}{r_1} = \frac{n_1}{n_2} \quad (9)$$

$$\cot \Theta = \frac{r_2 d_2}{r_1 d_1} \quad (10)$$

$$D_1 = d_1 + \frac{2}{P} \quad (11)$$

$$D_2 = d_2 + \frac{2}{P} \quad (12)$$

$$L_1 = \pi d_1 \cot \Theta \quad (13)$$

$$L_2 = \pi d_2 \cot \phi \quad (14)$$

$$N_1 = n_1 \sec^3 \Theta \quad (15)$$

$$N_2 = n_2 \sec^3 \phi \quad (16)$$

Formulas (7) and (10) are for gears on shafts at *right angles only.*

If a table of secants is not obtainable, it will be necessary to use the cosine instead, and the formulas in which the secant occurs must be altered as follows:

$$d_1 = \frac{n_1}{P \cos \Theta} \quad (3)$$

$$d_2 = \frac{n_2}{P \cos \phi} \quad (4)$$

$$c = \frac{n_1}{2 P \cos \Theta} + \frac{n_2}{2 P \cos \phi} \quad (6)$$

$$N_1 = \frac{n_1}{cos^3\ \Theta} \qquad (15)$$

$$N_2 = \frac{n_2}{cos^3\ \phi} \qquad (16)$$

The formulas have been arranged with the idea that they may be copied in a note book along with the diagram, Fig. 7, which may help to make the meaning of the different characters used in the notations more clear. They are universal with the exception that (10) applies when the shafts are at right angles only, and that in case of shafts at an acute angle (7a) is used in place of (7) and it is very necessary in this case to bear in mind rules 1, 2, and 3 given above. Close inspection of (7) and (7a) will reveal that (7a) is the general formula, and is contracted to (7) for the more frequent case where the shafts are at 90 degrees, as in the denominator we find the ratio

$$\frac{cos\ \Theta}{cos\ \phi}$$

which is equal to *cot* Θ when Θ and ϕ are complementary angles. Formulas (7) and (10) are from Mr. Halsey's book.

Second-class Mail Matter

Wilmer Atkinson, editor of the *Farm Journal*, of Philadelphia, sends us a pamphlet, in which he undertakes to show that the charges brought against second-class mail matter, with regard to causing the postal deficiency, are not well based because this second-class matter results in and produces most of the first- and third-class matter which is carried at paying rates. The argument is ingenious and there is some point in it, but we think Mr. Atkinson should not ignore the fact that the railroads receive exorbitant prices for carrying mails; that weight for weight they get more money for carrying mail matter than they do for first-class passengers, and that the terms they obtain from the Government for carrying the mails could not be obtained if the roads did not maintain an expensive lobby at Washington for the purpose of perpetuating these conditions.

To increase the navigable depth of the Chicago river, as required by the Government, it will be necessary to lower the three existing tunnels under the bed of the river, two of which belong to the city, the third being the property of the Union Traction Company of that city. In lowering the city tunnels the plan prepared by the city engineer embraces building a new flat roof about mid-hight in the tunnels, this new roof to be supported by the existing side walls. The original arch roof will then be broken in and removed, and the grading, flooring and construction of the new portion of the side walls made necessary by the lowering operation will be begun.—*Commercial America.*

SOME SPECIALTIES OF A BALTIMORE SHOP

A Machine for Cooking and Filling 40,000 Cans of Corn a Day Automatically—Rotary Pressure Blowers and Their Manufacture

The shop of William Hollingsworth, 227 North Holliday street, Baltimore, Md., is one which combines some regular lines of manufacture, including positive pressure blowers, internal combustion engines, etc., with the building of a variety of special machinery and a general machine business, being well prepared for the cutting of gears and cams.

A THIN PLANING JOB.

Among the special jobs which they execute is the machining on a Detrick & Harvey open-side planer of a class of castings variously denominated as half-type-high beds, false beds, or chase plates, used on a label-printing press. These plates are themselves quite interesting. They are used in making up forms consisting of a number of electrotypes, which latter, including their metal backing, are half-type high and are trimmed to

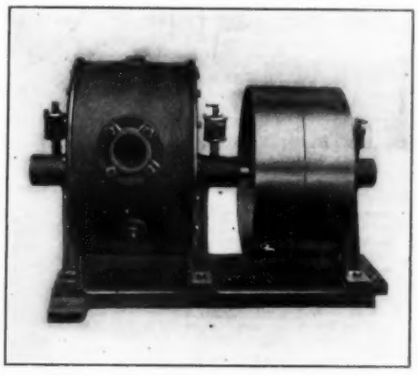


FIG. 1. "LORD BALTIMORE" ROTARY PRESSURE BLOWER, BORE 18 IN. DIAM. X 12 IN.

gage or register marks and to as accurate thickness as possible, so as to save time in making ready and accurately registering the color plates. The other half of the necessary hight is made up by the false bed. (The standard hight of type is 0.918 inch). When "making ready" on the press a full sized sheet is placed between the press bed and the false bed, and on this "make-ready" sheet are pasted additional pieces of paper so as to show a proper impression. This is a peculiar feature of the matter, since the offset due to this extra thickness must be transmitted through the cast-iron false bed, which therefore is liable to be bent in different places, sometimes as much as ten or fifteen thousandths of an inch, and this only a short distance away from where there is no underlay and the bed is not bent at all. The casting is not simply sprung but appears to be bent like a sheet of lead. Some of them after over ten years of this treatment are still as good as ever; occasionally they are sent back for straightening, and have their health restored by a lead-hammer treatment. This, however, very rarely becomes necessary if "dead soft" iron be used in making them. Mr. Hollingsworth has the beds made of the softest iron he can get the foundry to furnish. He is making some as large as 47¾x62 inches, which is quite a job for a planer which was built as a 30x30-inch, with a table 22 inches wide, later extended to 36 inches wide. The beds are cast 11/16 inch thick and are finished by a great number of light cuts, some not more than 0.003 inch deep, with a feed of from ⅛ to ¼ inch. The castings rarely come flat, but this does not matter much if the iron is soft, as it should be. They are placed on the planer, concave side up, clamped down at the edges, and a rough cut taken with a pointed tool. This takes off the scale and partially straightens the plate by the cutting action of the tool. The plate is then turned over and driven down with a lead hammer until it is approximately flat; a rough cut is then taken off, the clamps are loosened again and more attention is given with the lead hammer. The process of taking a light cut, loosening up and straightening with the hammer, and turning over, is repeated many times, until the thickness has been reduced to from 0.457 to 0.460 inch.

The printers keep extra beds on hand upon which to make up the forms while others are being used on the press, thus avoiding the necessity of holding the presses idle while forms are made up. To one outside of the printing business it would at first sight appear more reasonable to place the paper liners under the electros, between the latter and the chase plate, and thus avoid bending the chase plate; this, however, would involve unlocking the forms after a proof had been taken and lifting out the electros again. So they use the much simpler plan of leaving the form undisturbed and placing the make-ready sheet and paper liners under the bed.

PRESSURE BLOWERS AND AN INSERTED-TOOTH CUTTER.

Mr. Hollingsworth makes a line of rotary pressure blowers, the No. 1 or smallest size running at 600 revolutions per minute maximum speed and capable of a maximum presure of 5 pounds, the capacity being 1½ cubic feet of free air per 100 revolutions. The maximum speed of the No. 2 size is 500 revolutions, capacity 3 cubic feet of free air per 100 revolutions, and several larger sizes are built. Fig. 1 shows a large one having an 18-inch

bore 12 inches long and capable of furnishing 160 cubic feet of free air per minute at 200 revolutions, 200 cubic feet at 250 revolutions per minute; it has a 3-inch pipe flange.

The blower consists of a base casting upon which is mounted the cylinder; in Fig. 2, at *A*, is a detail of the cylinder for the No. 2 machine. The bearings in the cylinder heads are bushed down to 5/8 inch; the brass bushings are not shown in the cut. At the other end of the base is the outer bearing, and running in the three bearings is the shaft *C*, carrying tight and loose pulleys and the rotor. The latter consists of a main cylindrical casting *D*, Fig. 2, with four deep slots in which slide plates *E*, made of cold-drawn steel, which are continually pressed outward by springs and have along their outer edges steel rubbing strips or contact pieces *F*, which rock in grooves in the edges of the plates. The center line of the rotor, of course, does not coincide with that of the cylinder in which it revolves, but is offset, as can be seen in the drawing of the cylinder head *B*.

In order to cut the slots in the rotor, an inserted tooth cutter, similar to the one shown in Fig. 3, is used. One of these tools, made about 1899, has been in hard service since that time without having shown any weakness of any kind; in July, 1902, it had a second set of teeth made, and in August, 1905, a third set, which is now in use. This cutter has a body 9 7/16 inches diameter, and 9/16 inch thick, into which are inserted 12 Jessop-steel teeth which are 5/8 inch wide on the cutting edge, 11/16 inch long from front to back, 1/2 inch wide on the back edge, and have shanks 1/2 inch diameter and 1 inch long, and are retained by 3/8-inch set screws, whose direction of pressure is such as to hold the teeth down on their shoulders; the shank has a nick in it at the proper angle to give a square bearing for the set screw. The faces of the teeth abut against a step on the cutter body, which prevents the teeth from turning in their holes. The face of the tooth lies in a plane passing through the axis of the cutter. The outside diameter of the cutter is 10 3/4 inches.

The slots in the rotor are cored 3/8 inch wide and 3 3/8 inches deep, and are finished to 5/8 inch wide and 3 5/8 inches deep, each slot being finished at one pass. This is a severe test of the cutter teeth, for the castings are not pickled, and much hard scale and burnt sand has to be cut through.

Fig. 3 shows a larger cutter made recently, which has a body 13 inches in diameter, 23/32 inch thick, bore 1 1/4 inches; teeth 3/4 inch wide, with shanks 9/16 inch diameter and 1 inch long; made of "Blue Chip" steel. In the illustration one tooth is shown removed from the body.

Fig. 4 shows this cutter in use in a No. 3 plain Cincinnati milling machine, at work on the rotor for the blower shown in Fig 1. The diameter of the cutter over all is 14 5/8 inches, which was too large to clear the overhanging arm of the miller, so a slot was cut in the arm to allow the cutter to clear it.

THE QUEEN ANNE CORN COOKER-FILLER.

At the time of my visit Mr. Hollingsworth had under construction a number of machines which illustrate the versatility of his establishment and which, though of a type different from the majority of the work done in machine shops, had many points in design and construction which attracted one's attention. Machinery in canning factories (of which there are very many in Maryland) doesn't have around it at all times men who are experts in the handling and construction of machinery, but on the contrary must be designed to withstand ignorance, neglect, and often to some extent abuse, and the construction should be such as to permit of repairs being made with the least possible delay,

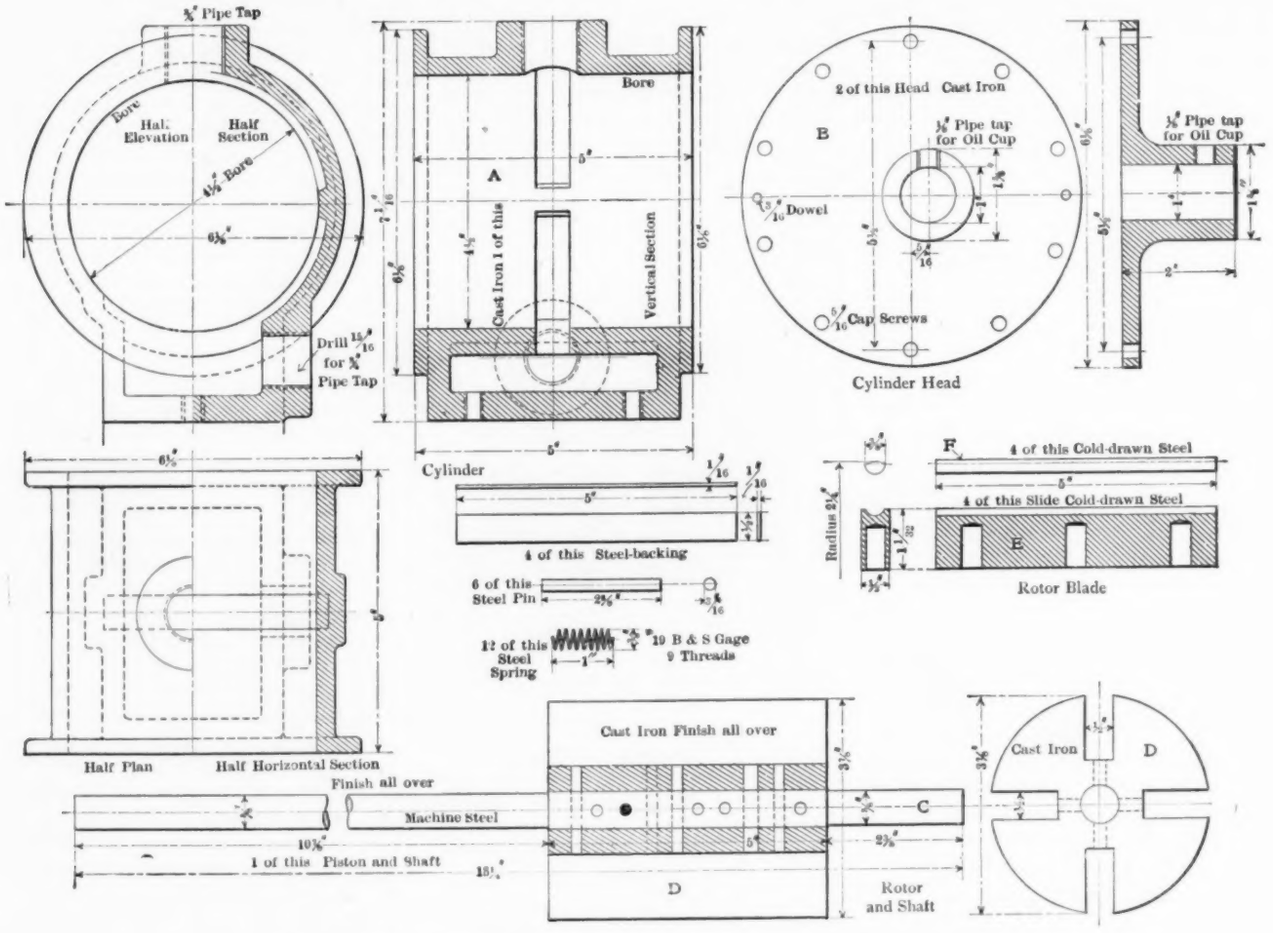


FIG. 2. SOME DETAILS OF NO. 2 (4 1/2 X 5 IN.) ROTARY PRESSURE BLOWER.

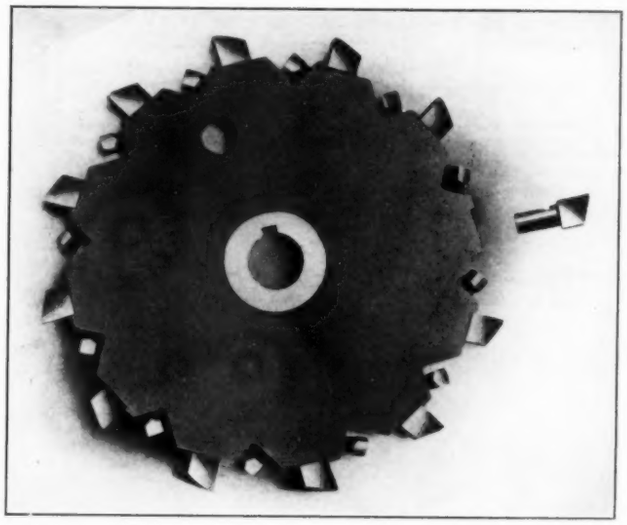


FIG. 3. INSERTED TOOTH CUTTER FOR THE ROTOR SLOTS.

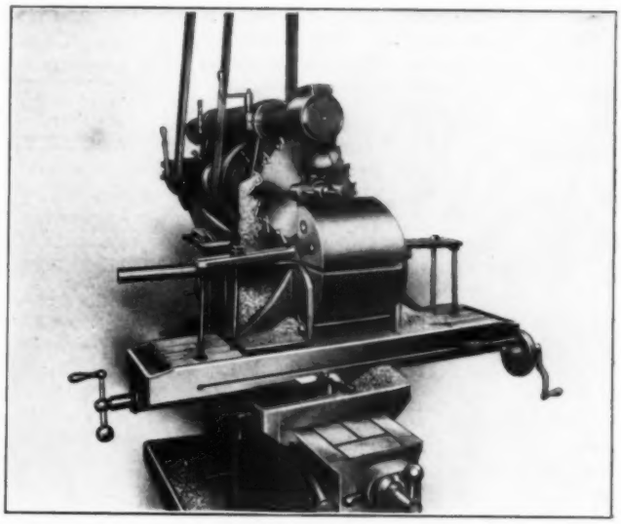


FIG. 4. MILLING A SLOT IN THE ROTOR.

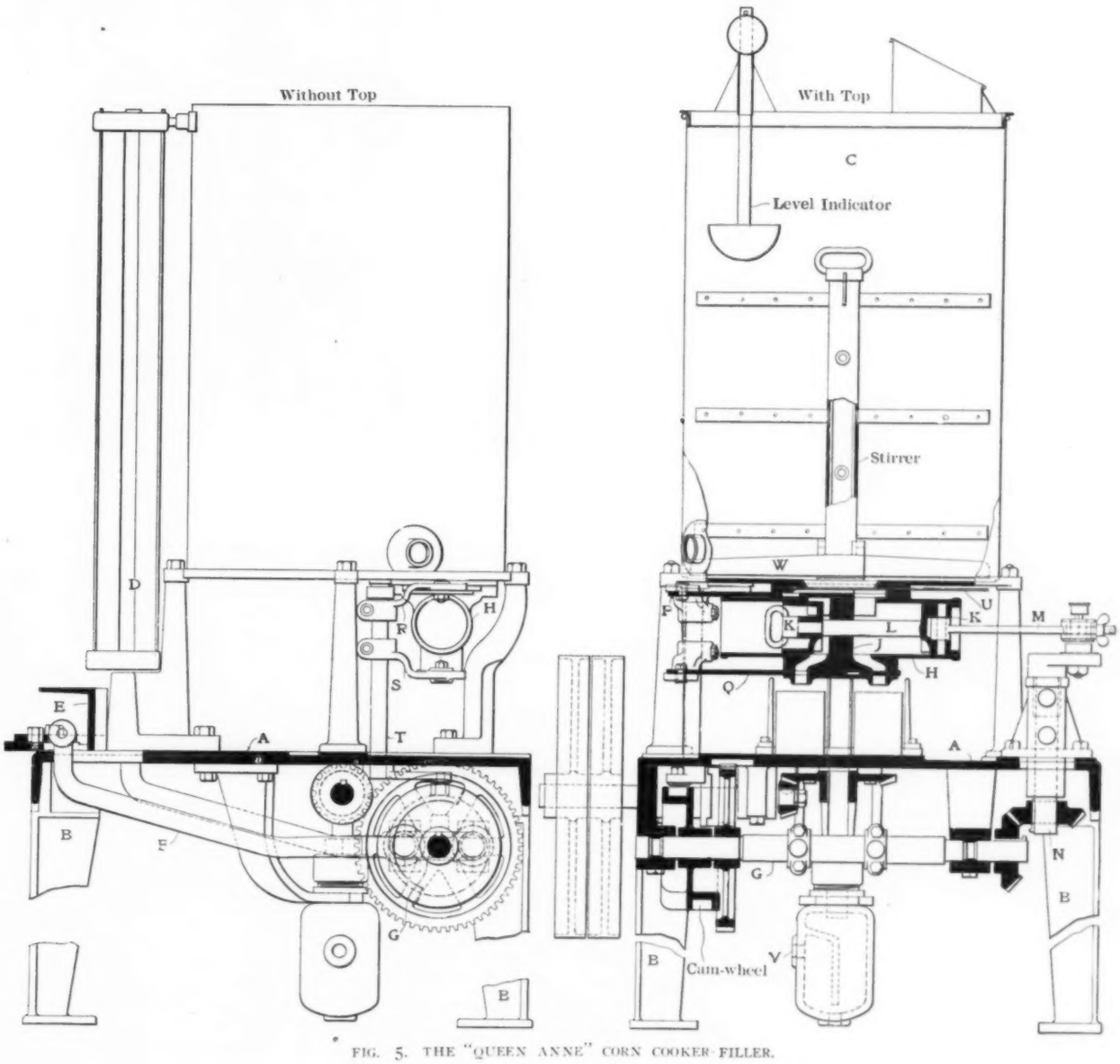


FIG. 5. THE "QUEEN ANNE" CORN COOKER FILLER.

so that the putting up of the season's crop may not be held back.

The Queen Anne cooker-filler, which is the machine referred to, will cook the corn and fill the cans, automatically feeding the cans under the filling mechanism and measuring out exactly one canful of corn without overflow, filling the can and pushing it out of the way on to the "wiper disk," at the rate of 40,000 cans in ten hours. Its general arrangement is shown in Fig. 5, which consists of two elevations —partly in section—on planes at right angles to one another. *A* is the cast iron table or bed-plate of the machine supported on four legs *B*. *C* is the large cylindrical receptacle in which the corn is cooked by steam. *D* is one of the two parallel vertical racks which in service hold two columns of empty cans piled one above another. *E* is one of the two pushers which is moved back and forth by a connecting rod *F* driven from the crank-shaft *G*, and which pushes on the back end of a horizontal row of empty cans resting on the bed plate, so that at every forward stroke a can is pushed under the filling mechanism, and at every backward stroke another can drops down out of the rack and takes a place at the back of the row. The filling mechanism consists principally of the cylinder *H*, having in its middle a vertical fixed partition *J* and having movable ends or pistons *K K* connected together by a piston rod *L* and caused to reciprocate by the connecting rod *M*, actuated by a crank on a vertical shaft *N*. It will be seen from the section that the cylinder has ports in its upper and lower sides at each side of the vertical partition, and these ports are provided with inlet and discharge valves of a very simple form, being merely thin plates *P* and *Q* with openings in them, so located, and subject to motion at the proper time by the rocker-arms *R* and *S* on the vertical rock-shaft *T*, that when the piston at one end of the cylinder is drawn out, the inlet valve is open, admits a charge of corn from the cooker above, and then closes, and immediately the discharge valve opens and the piston shoves the charge into the empty can below. At the same time the filled can under the opposite end of the cylinder is pushed out of the way by the pusher *E* at the back of the row of cans on that side. When the piston reaches the end of its stroke the discharge valve closes and the filled can on this side is in its turn pushed out of the way by the other pusher. This whole cycle of operations is performed in less than a second. *U* is what I would call a stop-valve or throttle valve, though I believe they call it a shut-off gate. It enables the corn to be shut off from the filling mechanism for any reason, such as trouble with the latter, which might perhaps necessitate removal of the piston; the provision of this gate enables this to be done without the escape of the contents of the cooker.

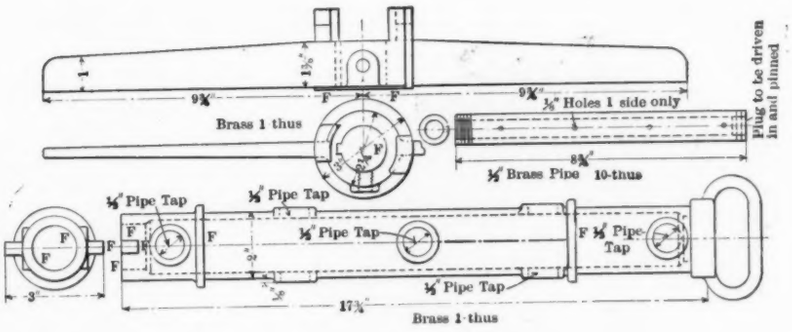


FIG. 6. THE PRINCIPAL PARTS OF THE STIRRER.

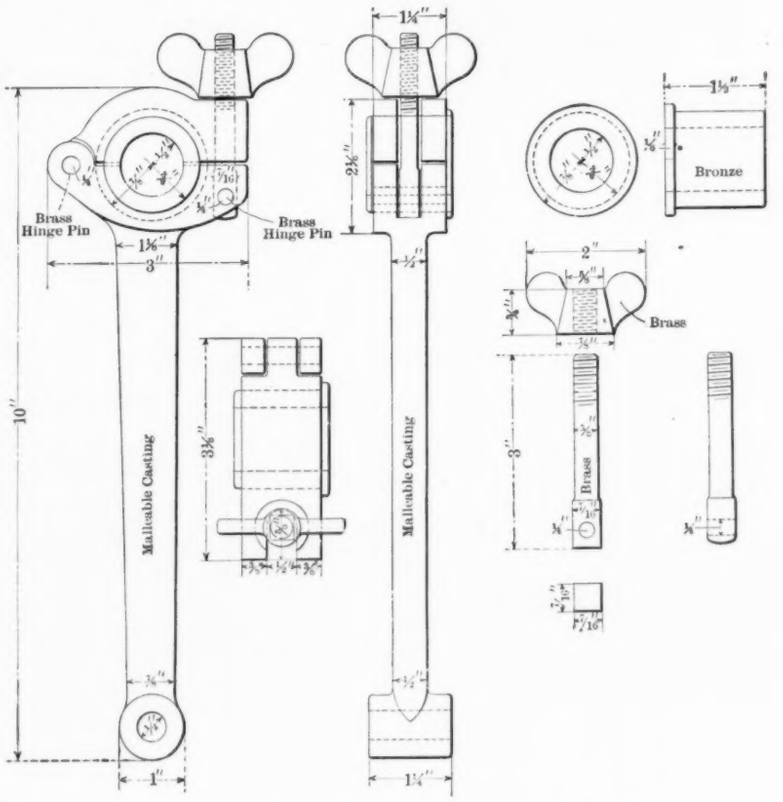


FIG. 7. CONNECTING ROD M FOR CORN COOKER-FILLER.

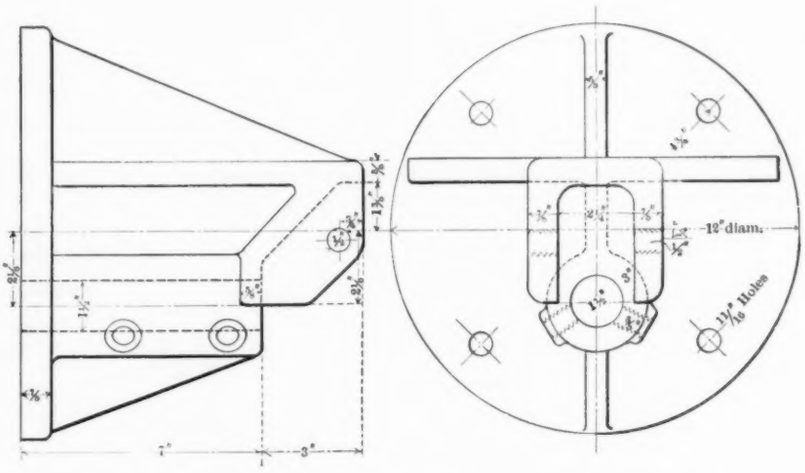


FIG. 8. FIXTURE FOR TURNING CRANK PINS FOR CORN COOKER-FILLERS.

I will not take space for an analysis of all the details of the machine, but think it is worth while to refer to the design of the stirrer, which is rotated in the cooker by the vertical shaft which extends up through the middle of its bottom. The starch of the corn burns on the stirrer, causes particles of husk, silk, etc., to stick to it, and later this comes off and gets into the canned goods if precautions be not taken to prevent it. So in a properly run establishment the stirrer should be removed in the evening and left in a vessel over night to permit of easily removing the foreign matter the next morning. As can be seen in Figs. 5 and 6 the stirrer consists of a series of one-half inch brass pipes, each perforated with a row of ⅛-inch holes along one side and fixed radially to a central vertical hollow shaft into which steam is led from the connection at *V*, Fig. 5. There is also connected to the shaft a solid arm *W* at the bottom. When it is desired to remove the stirrer, the handle at the top is taken hold of and given a twist and a lift, which unhooks the lugs at the bottom and enables the brass casting, shown in detail in Fig. 6, to be lifted off, carrying the pipe arms with it.

The connecting rod *M* has an interesting feature in the design of its big end. It is shown assembled and in detail in Fig. 7. The construction is such as to permit of disconnecting the rod from the crank-pin in a jiffy when necessary, there being only one thumb nut to slacken up (not to remove). This facilitates removing the pistons from the cylinder. The construction may be quite clearly seen from the details, the rod being a malleable casting and the bronze bushing being clamped tight by the hinged cap when in use.

Mr. Hollingsworth has for years found much interest and profit from the reading of the AMERICAN MACHINIST, and the crankshafts of the cooker-fillers have their crank-pins turned in a device shown in Fig. 8, which was designed partly after one described in these pages.

H. J. K.

[In the description at pages 10 and 11 of the pulley grinding machine constructed in this shop, one of the illustrations of the machine was by accident omitted, and it is accordingly inserted here as Fig. 9.—Ed.]

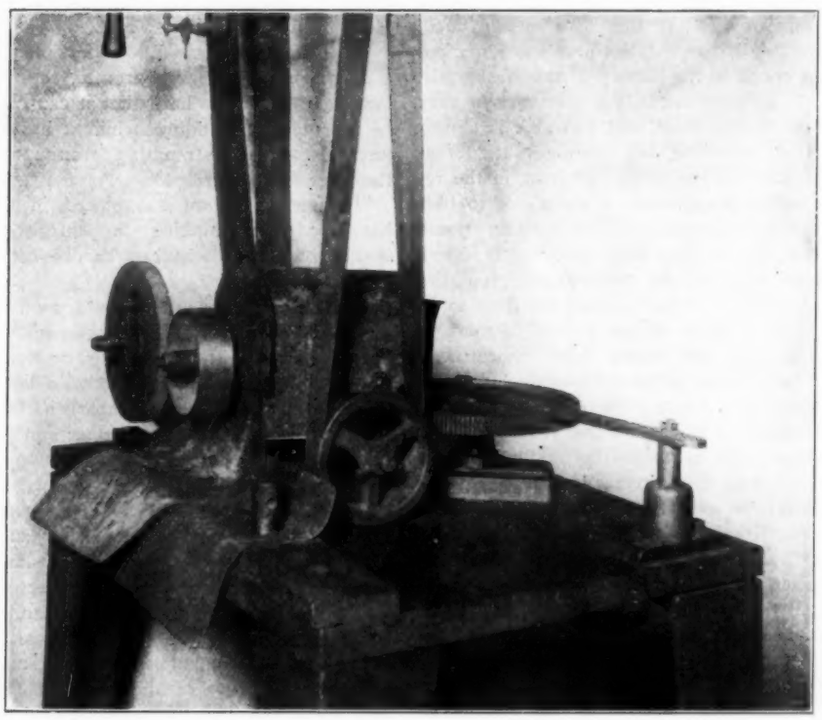


FIG. 9. MACHINE FOR GRINDING FACES OF PULLEYS.

According to the *Mechanical Engineer*, of London, the memorandum and statistical tables on the production and consumption of iron ore and pig iron, and the production of steel in the United Kingdom, published in a Parliamentary return a few days ago, state that the quantity of steel produced by the open-hearth process in the United Kingdom is at present about double of that produced by the bessemer process. In Germany, on the other hand, the proportion is reversed, about two-thirds of the total production consisting of bessemer steel, while in the United States also the production of bessemer steel considerably exceeds that of steel produced by the open-hearth process.

The Use of Vanadium in Steel Manufacture*

BY B. E. D. STAFFORD.

James Lappan, an honored member of your association, was quite interested in some of the experiments being made under the direction of the American Vanadium Company, who are miners of vanadium ore, with various steels in which vanadium, in the ferro-vanadium state, was introduced as an alloy. So remarkable were the results obtained with so small a proportion of the vanadium added, that he was quite enthusiastic over the subject, and was most anxious to have the members of this convention familiar with what others were doing in the steel world with this most important element, so recently found valuable throughout the process of manufacturing steel. I will say, however, that the use of vanadium so far has been confined to European practice, for the reason that the supply has been very limited, and was considered more of a laboratory curiosity than a possible factor destined to revolutionize the process of steel manufacture, and while the American Vanadium Company has discovered a very large supply of vanadium ore, it has not, up to the present time, gone so far in its experiments as to determine what the outcome will be as regards its use in the hands of the American steel makers, and for that reason it would be inopportune for me to say anything further, other than to call your attention to a pamphlet, several of which I have brought with me, which in a brief way gives a history of vanadium and its use by European metallurgists in steels to meet the demands of automobile practice. It is a reprint, taken from the *Motor Age*, of an address delivered by Prof. Alex E. Tucker before the Automobile and Cycle Engineers Institute of England.

An automobile car is a great testing machine for reasons of small dimensions, which are necessary for beauty of design and compactness of parts, and we can readily realize the enormous strain on all materials used, when we consider the forces which produce them—the car running over country road at speeds of from 35 to 40 miles per hour, more or less.

I understand that in France there is a car which is pronounced unbreakable in its material parts, conveying the fact that all parts are constructed of materials so high in their physical characteristics of elastic limit and resistance to impact and torsional strains, and capable of maintaining the general qualities throughout service, that no strains or stresses incidental to road practice can come anywhere near the yield point of the mate-

*A paper read before the convention of the American Boiler Manufacturers' Association, at Pittsburg, Penn., Sept. 18, 1906.

rials involved. These steels are known as vanadium, nickel vanadium and nickel chrome vanadium steels, and certain of the castings in use contain small proportions of vanadium.

As manufacturers of boilers, you can readily understand the importance of this condition should such be established—and it is not at all improbable—and it points conclusively to the fact that we should not be unmindful of the combined stresses, so disastrous to materials involved, in failing to provide materials to resist such with a high margin of safety; for it is a known condition in quite a few instances of mechanical design where strains and the stresses which produce them exceed the elastic limit, in fact the yield point, of the materials used, and the fatiguing, rupture and final separation of the molecular structure of many steels now in use, are due to the fact that the yield point is not far enough removed to obviate the effect, and structures are not of that nature to withstand static stresses produced; if European steel makers, by the use of vanadium, can in any way point to materials which are in a sense immune from breakage, there is no question of a doubt but that American steel makers will profit by the outcome, as well as the designers.

At the present time, I can offer no information which would be valuable to the boiler manufacturer, from the standpoint of any of the experiments made by us, other than to point to the results gotten in other fields, which are very promising. We may look to some improvement in the plain carbon-manganese steel, by the use of a small proportion of vanadium, and if it is possible to produce boiler plate and material for the use of braces, stays, tubes, etc., whose elastic limit will approach the tensile strength of the material now used, with the general structure improved as regards its power to resist forces which tend to rupture, and with the cost not far in excess of what is now established, vanadium, in my mind, will be the means of accomplishing this in the hands of steel makers who understand its application to the present process.

For your information, I will state that in plain carbon-manganese steel, with an addition of 0.25 per cent. vanadium, the tensile strength was raised 65 per cent. and the elastic limit 68 per cent., without in any way impairing the structure to withstand the regular physical tests. With the same carbon-manganese steel, with 3.34 per cent. nickel added, showing a tensile strength of 94,528 lb. per square inch and elastic limit of 73,024 lb. per square inch, by the addition of 0.25 per cent. vanadium, the tensile strength was increased 61 per cent. which was equivalent to 152,678 lb. per square inch and the elastic limit was raised 64 per cent. or to 112,539 lb. per square inch and gave an elongation in 2 inches of 26 per cent. and a contraction of area of 52 per cent.

In these specimens, we are enabled to notice what a marked influence a small quantity of vanadium has in changing the entire structure of the steel, and most favorable is the fact that the increase in the elastic limit in each instance is higher in proportion than that of the tensile strength.

In the London publication of the *Engineering Times*, issued April 5, 1906, J. Kent Smith presents an article on vanadium and its several uses to the steel manufacturers. I will quote a few extracts therefrom, as follows:

"During the past few years the element vanadium has sprung from the position of a substance having an interest more or less academic, speaking from a metallurgical point of view, to that of a metal which, suitably harnessed, has practically marked an epoch in the history of the steel trade.

"The pure metal is a substance of very high fusing point, and its value is almost purely scientific, but the observation that an alloy of vanadium and iron, in the respective proportions of about one to two, has a comparatively low melting point, and that the element, judiciously used, conferred almost miraculous properties upon steel, at once opened the door to its probable utility in the service of man.

"A demand having been indicated, a supply was soon forthcoming. Fresh sources of the metal were discovered and studied, its extraction and reduction from these sources most thoroughly worked upon and the correct application of the metal to special steel manufacture consistently and untiringly inquired into.

"Vanadium has rendered possible combinations of excellence under both statically and kinetically applied stresses which were hitherto undreamt of; and many different types of vanadium steel, each type being specially designed to meet some particular requirement in the highest degree, while combining in other respects the attributes of only the very best steels, are now regular commercial products of the Queensferry Works.

"To briefly epitomize some of these types: A steel is made which has an elastic limit of 45 tons to the square inch (that is to say, a bar of one square inch area of this steel would hold in suspension a weight of 45 tons before stretching) and which will not break until another twelve tons are added, while at the same time it is so ductile that the bar will bend double cold without breaking. A great amount of power is required to perform this bending. With these qualities under steady load, the steel will withstand a severe shock as well as an excellent specimen of dead mild steel having only one-third of its strength, withstands repeated blows even better, has a superior wearing surface to any metal known which is not brittle, and resists fatigue to an enormously greater degree than the best qualities of mild steel. A metal suitable in this degree for manufacture of many engineering parts is unattainable by any other means than by the use of vanadium.

"Another type of vanadium steel has an elastic limit of 25 tons to the square inch while it is more ductile than the best dead mild steel or iron, and resists torsional strain to the highest extent known in steel or iron. A round bar of it, twisted absolutely in the straight, will turn upon itself five times before shearing itself, which it finally does under a load of about 40 tons to the square inch.

"Other types which have strengths under steady load even greater than those quoted, are so malleable that bars of them may be knotted cold, and yet are so susceptible to temper that a rod thus cold-knotted will give a point which, if quenched in water from a red heat, will cut glass.

"Still another type renders possible, by a simple case-hardening process, the obtaining of a skin so hard that it can only be indented by grinding, while it has an internal core of a strength approximating the steel first described.

"In fact vanadium has placed in the hands of the thinking metallurgist a weapon whose power can hardly be at present estimated.

"Broken railway axles should soon be placed in the history of the past; an amount of energy can be transmitted by, or stored up in a shaft of almost incredible lightness; springs may be made nearly half the weight of the best now existing, and yet having a better tenacity and a much longer life; ships can be driven at greatly increased speeds with safety; the flying machine problem comes a step nearer solution, while the question of armor plates, big guns and their carriages, projectiles, and the like, enters on a new phase, and in bridge building spans become possible that were not contemplated in the most sanguine moments of the designer of a few years ago, and such are all rendered possible by the judicious harnessing of an element which, with its compounds, was looked upon up to a few years ago almost as a chemical curiosity."

Irrigation Progress in the West

Commercial America states that to show for four years of work by the United States Reclamation Service, which has charge of the great irrigation scheme in the West, there are 22 projects now under way. Water has already been supplied to 13,600 acres of hitherto barren soil. Up to July 1, 1906, there had been constructed 241 miles of main canal and 504 miles of distributing canals and ditches, 5½ miles of tunnels have been driven and 233 miles of wagon road have been constructed, largely in solid rock. Three hundred office and other buildings necessary in the work have been erected, and 520 miles of telephone lines have been installed and are now in operation. From the Government cement mill at Roosevelt, Arizona, 43,000 barrels of cement have been turned out.

Report of the American Society of Mechanical Engineers' Committee on Standard Proportions for Machine Screws*

Mr. President and Gentlemen:

Your committee, having been intrusted with the consideration of a Standard for the Proportions for Machine Screws, has the honor to present the following report:

At a joint meeting held in New York, April 11, 1904, at which were present, representing the screw manufacturers,

Mr. Chas. Glover, President The Corbin Screw Corporation, New Britain, Conn.,

Mr. Benj. Thurston, General Superintendent American Screw Company, Providence, R. I., and The Worcester Machine Screw Company,

Mr. E. O. Goss, Treasurer The Scovill Manufacturing Company, Waterbury, Conn.,

and the members of your committee,

Wilfred Lewis, Chairman,
Charles C. Tyler,
Horace K. Jones,
Geo. R. Stetson,
J. F. Madgett, Asst. Supt., General Electric Company (representing Jno. Riddell, member of committee),
George M. Bond,

certain diameters, pitches and limits for standard machine screws were unanimously agreed upon, including recommendations as to the best practical methods for establishing and maintaining such Standard Sizes, Pitches and Limits.

Since the date of this joint meeting, however, it has been found advisable to modify the list of machine screw sizes which were agreed upon at that time, to exclude the diameters 0.3125 (5-16 in.) and 0.4375 (7-16 in.), these being already included and established under the Sellers or United States Standard System, well known and designated fractionally, and to replace them by the addition of three sizes, as follows:

0.240.....24 per inch.
0.270.....22 " "
0.320.....20 " "

These additional sizes all closely approximate regularly listed machine screws corresponding, and have been, and are now made in large quantities. The further advantage considered by your committee in recommending this change is that the three new sizes, and all in the list as now proposed and agreed upon, require but three decimal places to express their exact diameter, while those rejected involve the use of four.

It was also found advisable to slightly change the limits of variation for the taps corresponding to the sizes of machine screws agreed upon, to allow for possible errors in the lead or pitch of the thread and in the diameter, due to hardening, unavoidable in their manufacture.

In the consideration of this subject, your committee believes the following combined details to be essential in establishing and maintaining a standard for the diameters, threads and heads of machine screws, including, as it does, diameters, threads and limits for the taps which are to be used in connection therewith:

Form of Thread,
Diameters,
Number of Threads per Inch,
Standard Reference Thread Gauges, Basic and for Screws and Taps,
Working Gauges for Screws and for Taps,
Limits of Variation, measured in the Angle of the Thread,
Limits of Variation in External Diameter,
Limits of Variation in the Pitch of the Thread, Screws and Taps,
Proportions of the Heads.

FORM OF THREAD.

The Sellers, or U. S. form of thread, having an included angle of 60 degrees, and a truncation or flat at the top and bottom of the thread equal to one-eighth of the pitch of the thread, shall be used for the basic standards.

The form of thread for machine screws shall have an included angle of 60 degrees, a truncation or flat at the top of the thread equal to one-eighth of the pitch, and a truncation at the bottom of the thread equal to one-sixteenth of the pitch.

The form of thread for machine screw taps shall have an included angle of 60 degrees, a truncation or flat at the top of the thread equal to one-sixteenth of the pitch, and a truncation or flat at the bottom of the thread equal to one-eighth of the pitch.

DIAMETERS.

The diameters of machine screws shall be expressed in decimal sub-divisions of an inch.

The standard diameters for machine screws, when measured over the top of the thread, shall be the fourteen sizes given in Table I.

NUMBER OF THREADS PER INCH.

The standard number of threads per inch for the fourteen sizes of machine screws shall be those also given in Table I.

STANDARD REFERENCE THREAD GAUGES.

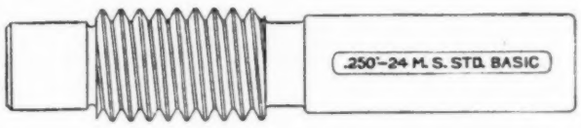
As stated in the paper by Mr. Chas. C. Tyler (pages 608-9, Vol. XXIII, *Transactions*), in order "To secure the interchangeability of machine screws and taps, a practical system of gauging should be provided, and ultimate standards of reference are desirable, particularly in cases of disputed thread sizes. The modifications of the form of thread for screws and taps to give clearance, each being based on the United States standard thread, make it seem desirable to provide three sets of standard reference thread gauges for each gauge diameter; one basic, one for screws, and one for taps."

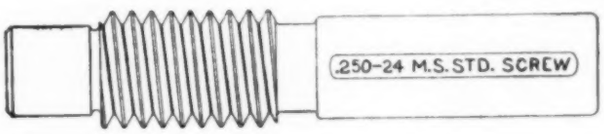
The thread dimensions of these standard reference thread gauges are given in Table II.

The pitch diameters, given in the eighth column of Table II, are the diameters when measured in the angle of the thread, at points equi-distant from the top and bottom of the threads of the basic standards.

BASIC STANDARD REFERENCE THREAD GAUGES.

Following further the text of Mr.





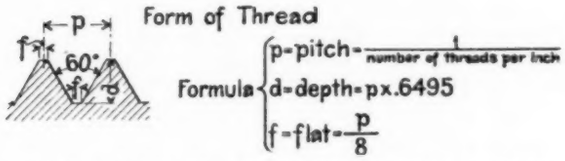


FIG. 1.—BASIC STANDARD REFERENCE THREAD GAUGES.

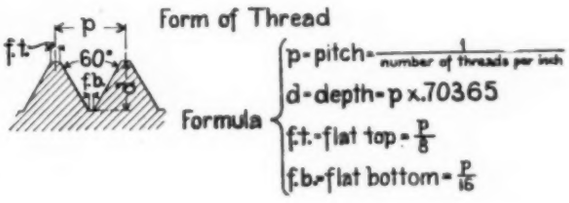


FIG. 2.—STANDARD REFERENCE THREAD GAUGES FOR SCREWS.

*Presented at the New York Meeting (December, 1905.) of the American Society of Mechanical Engineers.

Tyler's paper, referred to, with slight modifications, your committee recommends as the foundation of the system, a set of basic standard reference thread gages, these gages to be made of unhardened steel, of 0.35 per cent. to 0.40 per cent. carbon, to represent exactly in every detail, the U. S. form of thread, the diameter at the top of the thread, the diameter at the bottom of the thread, and the correct pitch; the included angle of 60 degrees and the flat top and bottom of the thread equal to one-eighth of the pitch. Each basic standard gage to have plainly marked thereon the diameter, number of threads per inch and "M. S. Standard Basic" (machine screw standard), as shown in Fig. 1, herewith. The basic standards to be used only for comparative calibration, in the making of the reference standard plug thread gages for screws and taps. (See columns 5, 6, 7 and 8, Table II.)

STANDARD REFERENCE THREAD GAGES FOR SCREWS.

These gages are to be made also of unhardened steel, 0.35 per cent. to 0.40 per cent. carbon, to represent exactly, in every detail, a screw having the modified U. S. form, *i.e.*, a flat at top of one-eighth of the pitch, and at bottom of one-sixteenth of the pitch, with an included angle of 60 degrees, the exact diameter at the top and at the bottom of the thread and the correct number of threads per inch. Each standard gage for screws to have plainly marked thereon the diameter, number of threads per inch, and "M. S. Standard Screw," as shown in Fig. 27.

The gages for screws should be exact duplicates of the basic standards, in external diameter, pitch and number of threads per inch, also in pitch diameter, measured in the angle of the thread, but to be less in diameter at the bottom of the thread, corresponding to the decreased width of flat, which at this point is one-sixteenth of the pitch. These decreased root diameters are given in column 10, Table II.

All details for measurement, for basic and reference thread gages for screws, are given in Table II, excepting only those for width of flat, which are given in Table X, following.

STANDARD REFERENCE THREAD GAGES FOR TAPS.

These gages are also to be made of steel, 0.35 per cent. to 0.40 per cent. carbon, unhardened, to exactly represent, in every detail, the size of a threaded tap before being fluted, having the included angle 60 degrees, the flat at top one-sixteenth of the pitch, with flat at bottom of the thread equal to one-eighth of the pitch, and to correctly represent the standard pitch of thread. The external diameters to be as given in column 1, Table II.

TABLE 1.

STANDARD MACHINE SCREWS.

(Thread U. S. Form.)

Standard Diameter.	Number of Threads per Inch.
0.070 in.	72
0.085	64
0.100	56
0.110	48
0.125	44
0.140	40
0.165	36
0.190	32
0.215	28
0.240	24
0.250	24
0.270	22
0.320	20
0.375	16

TABLE II.

STANDARD REFERENCE THREAD GAUGES.

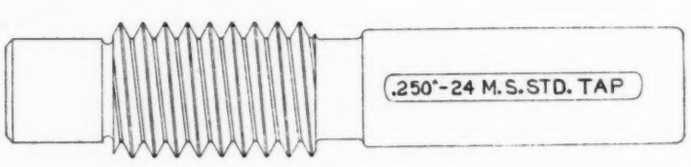
STANDARD GAUGES FOR TAPS. U. S. Form, except at Top of Thread, which is flat 1/8 Pitch.				BASIC STANDARD. Reference Thread Gauges, U. S. Form.				STANDARD GAUGES FOR SCREWS. U. S. Form, except 1/8 flat at Root.	
Diam. at Top of Thread.	Diameter at Root of Thread.	Pitch Diameter.	Excess Pitch Diameter over Basic.	Diam. Top of Thread.	No. Threads per Inch.	Diameter Root of Thread.	Pitch Diameter.	Diam. Top of Thread.	Diameter at Root of Thread.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
.07209	.05255	.06157	.00059	0.070	72	.05196	.06098	0.070	.05046
.08732	.06533	.07548	.00063	0.085	64	.06470	.07485	0.085	.06301
.10260	.07747	.08907	.00067	0.100	56	.07680	.08840	0.100	.07487
.11298	.08366	.09719	.00072	0.110	48	.08294	.09647	0.110	.08068
.12821	.09623	.11099	.00075	0.125	44	.09548	.11024	0.125	.09302
.14350	.10831	.12455	.00079	0.140	40	.10752	.12376	0.140	.10482
.16884	.12975	.14779	.00083	0.165	36	.12892	.14696	0.165	.12591
.19427	.15029	.17058	.00088	0.190	32	.14941	.16970	0.190	.14603
.21981	.16955	.19275	.00094	0.215	28	.16861	.19180	0.215	.16474
.24553	.18689	.21396	.00102	0.240	24	.18587	.21294	0.240	.18136
.25553	.19689	.22396	.00102	0.250	24	.19587	.22294	0.250	.19136
.27599	.21202	.24155	.00107	0.270	22	.21095	.24048	0.270	.20603
.32653	.25617	.28864	.00111	0.320	20	.25505	.28753	0.320	.24964
.38302	.29506	.33566	.00125	0.375	16	.29381	.33441	0.375	.28704

NOTE.—Diameter at Root of Thread, for Basic Standard Gauges,

$$= \text{Standard Diameter} - \frac{1.299038}{\text{No. Threads per Inch}}$$

Diameter at Root of Thread for Standard Gauges for Screws = Basic Root Diam. $- P(0.10825)$

Diam. Top of Thread, Standard Gauges for Taps = Standard Diam. $+ \sqrt{P} \times 0.005 + P(0.10825)$



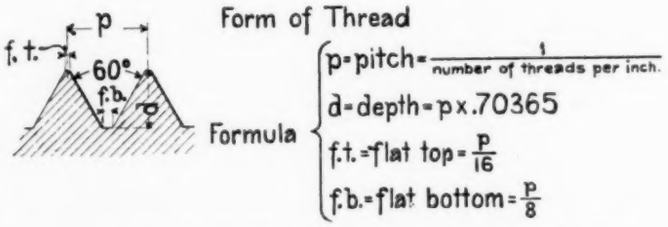


FIG. 3. STANDARD REFERENCE THREAD GAGES FOR TAPS.

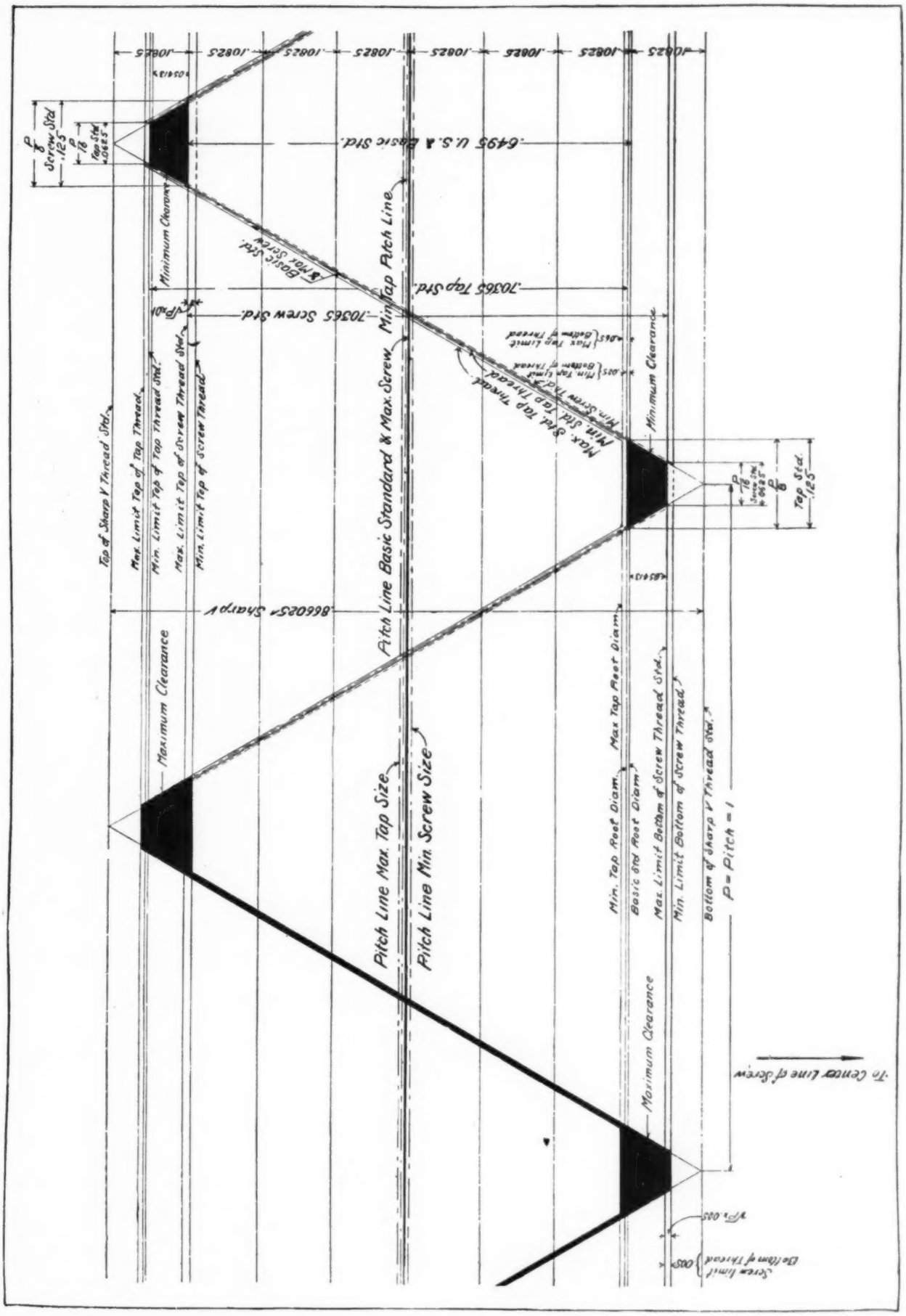

.6495 U. S. A Basic Std.
.10365 Tap Std.
.10365 Screw Std.
Minimum Clearance
Basic Std. Pitch Thread for Max. Screw
Min. Std. Tap Thread
Min. Screw Tap Limit
Max. Tap Limit
Top of Sharp V Thread Std.
Max. Limit Top of Tap Thread
Min. Limit Top of Tap Thread Std.
Max. Limit Top of Screw Thread Std.
Min. Limit Top of Screw Thread
.86602 Sharp V
Pitch Line Basic Standard & Max. Screw
Min. Tap Pitch Line
Maximum Clearance
Pitch Line Max. Tap Size
Pitch Line Min Screw Size
Min. Tap Root Diam.
Max Tap Root Diam.
Basic Std Root Diam.
Max. Limit Bottom of Screw Thread Std.
Min. Limit Bottom of Screw Thread
Bottom of Sharp V Thread Std.
P = Pitch = 1
To Center Line of Screw
Maximum Clearance
Top Std. .125
Screw Std. .125

FIG. 4. PROPORTIONS OF SCREW THREADS.

The increased external diameters there given are due to allowance for flat of one-sixteenth of the pitch and for error of lead due to hardening, as already mentioned. (See formula (a), Table VIII.)

The diameters at the bottom of the thread and in the angle at the pitch line, are given in columns 2 and 3, Table II. as also the excess of pitch diameter over that of the basic standard, in column 4.

Each standard for tap gages to have the diameter, number of threads per inch and "M. S. Standard Tap" plainly stamped thereon, as shown in Fig. 3.

Standard reference thread gages for screws and taps should be used *only* for comparative calibration in making working gages for such screws and taps, and to detect by such measurement the wear of the working gages in actual service.

WORKING GAGES FOR SCREWS AND TAPS.

The working gages for screws should be made of unhardened steel, and be exact duplicates of the standard reference thread gages for screws, in external diameter, in diameter at the bottom of the thread, in pitch and in diameter measured in the angle of the thread; each working gage for screws to have the diameter, number of threads per inch and "M. Screw" plainly stamped thereon.

For inspection of screws, your committee recommends the use of templet thread gages, made hardened, double end, plus and minus limits respectively, the holes being tapped to represent accurately the limits for screws given in columns 3 and 6, Table V. The thickness of these templet thread gages for each size screw is given in Table IX, and is designed to admit at the maximum end all screws that are within the limits, and to reject all that are larger, while screws smaller than the minus end of the templet gage are thus shown to be less in diameter than is specified by the minimum limit recommended by your committee.

The working gages for taps should also be made of unhardened steel, and to be exact duplicates of the standard reference thread gages for taps, in external diameter, in diameter at the bottom of the thread, in pitch and in diameter measured in the angle of the thread; each working gage to have the diameter, number of threads per inch and "M. S. Tap" plainly marked upon it.

The handles of all working gages to be of a form easily distinguished from that of the reference gages.

LIMITS OF VARIATION IN SCREW AND TAP DIAMETERS.

It is obvious that the thread sizes of machine screws and taps cannot be made commercially to correspond exactly with the standard gage dimensions herein recommended, and therefore established limits of variation are provided to prevent further controversy if the sizes of either are in dispute.

To insure the satisfactory fit of a screw in a tapped hole, it is evident that the screw should not be larger than the maximum working gage, although it may be a trifle smaller; and that a tap should not be smaller than the minimum working gage, though it may be somewhat larger. The variation from the working gage size, therefore, should always be *minus* for the screw and *plus* for the tap.

The limits of variation for the diameters of machine screws, when measured in the angle of the thread, are determined by the formula

$$\text{Limit} = \sqrt{\text{Pitch}} \times 0.01.$$

These limits are given in Table III, column 5.

The limits of variation for the external diameter of machine screws, measured over the top of the threads, shall be determined by the formula

$$\text{Limit} = \sqrt{\text{Pitch}} \times 0.02.$$

The limits for the fourteen sizes are given in Table IV, column 4. Limit diameters for machine screws, measured at the top of the thread, are given in Table V, columns 1 and 4.

LIMITS FOR MACHINE SCREW TAPS.

The minimum limits of variation for machine screw taps, measured in the angle of the thread, are given in Table VI.

The maximum limits, obtained by the use of the formula

$$\text{Max. limit} = \sqrt{\text{Pitch}} \times 0.008$$

TABLE III.

LIMITS OF VARIATION FOR DIAMETERS OF MACHINE SCREWS.
(Measured in the Angle of the Thread.)

Minimum Limit = Standard Pitch Diameter − $\sqrt{\text{Pitch}}$ × 0.01.
Maximum Limit being Standard Pitch Diameter.

Standard Diameter.	Threads per Inch.	Pitch, $\left(\frac{1}{n}\right)$.	Minimum Pitch Diameter.	Limit, (minus) $\sqrt{\text{Pitch}}$ × 0.01.
(1)	(2)	(3)	(4)	(5)
0.070	72	.013889	.05980	.00118
0.085	64	.015625	.07360	.00125
0.100	56	.017857	.08706	.00134
0.110	48	.020833	.09503	.00144
0.125	44	.022727	.10873	.00151
0.140	40	.025000	.12218	.00158
0.165	36	.027778	.14529	.00167
0.190	32	.031250	.16793	.00177
0.215	28	.035714	.18991	.00189
0.240	24	.041667	.21090	.00204
0.250	24	.041667	.22090	.00204
0.270	22	.045455	.23835	.00213
0.320	20	.050000	.28529	.00224
0.375	16	.062500	.33191	.00250

NOTE.—In the figures given for diameters and limits, derived from the use of the formulas here recommended, preference has been given in each instance to the decimal following the fifth figure which is 5 or more, thereby increasing the fifth figure by one.

The apparent slight discrepancy in doubling the limits in some instances is thus explained. The difference is, however, so small as to be quite beyond the limit of micrometer measurement.

TABLE IV.

LIMITS OF VARIATION FOR EXTERNAL THREAD DIAMETERS OF MACHINE SCREWS.

Minimum Limit Diameter = Standard Diameter − $\sqrt{\text{Pitch}}$ × 0.02. (Col. 4, Table V.)
Maximum Limit Diameter being Standard Diameter. (Col. 1, Table V.)

Standard Diameter.	Number of Threads per Inch.	Pitch of Thread. $\left(\frac{1}{n}\right)$	Minimum Limit. $\sqrt{\text{Pitch}}$ × 0.02.
(1)	(2)	(3)	(4)
0.070	72	.013889	.00236
0.085	64	.015625	.00250
0.100	56	.017857	.00267
0.110	48	.020833	.00289
0.125	44	.022727	.00301
0.140	40	.025000	.00316
0.165	36	.027778	.00333
0.190	32	.031250	.00353
0.215	28	.035714	.00378
0.240	24	.041667	.00408
0.250	24	.041667	.00408
0.270	22	.045455	.00426
0.320	20	.050000	.00447
0.375	16	.062500	.00500

TABLE V

LIMIT DIAMETERS FOR MACHINE SCREWS.
(Measured at Top of Thread.)

MAXIMUM. (Standard Diameter.)			MINIMUM. Standard Diameter = $\sqrt{\text{Pitch}} \times 0.02$.		
Diameter Top of Standard Thread.	Diameter Root of Thread.	Pitch Diameter.	Diameter Top of Thread.	Diameter Root of Thread.	Minimum Pitch Diameter.
(1)	(2)	(3)	(4)	(5)	(6)
0.070	.05046	.06098	.06764	.04928	.05980
0.085	.06301	.07485	.08250	.06176	.07360
0.100	.07487	.08840	.09733	.07353	.08706
0.110	.08068	.09647	.10711	.07924	.09503
0.125	.09302	.11024	.12199	.09151	.10873
0.140	.10482	.12376	.13684	.10324	.12218
0.165	.12591	.14696	.16167	.12424	.14529
0.190	.14603	.16970	.18647	.14426	.16793
0.215	.16474	.19180	.21122	.16285	.18991
0.240	.18136	.21294	.23592	.17932	.21090
0.250	.19136	.22294	.24592	.18932	.22090
0.270	.20603	.24048	.26574	.20390	.23835
0.320	.24964	.28753	31553	.24740	.28529
0.375	.28704	33441	.37000	.28454	.33191

NOTE.—Minimum Pitch Diameter = Standard Pitch Diameter − $\sqrt{\text{Pitch}} \times 0.01$.
Col. (2) = Standard Root Diameter − Pitch × 0.10825.
Col. (3) = Col. (6) + $\sqrt{\text{Pitch}} \times 0.01$.
Col. (4) = Standard Diameter − $\sqrt{\text{Pitch}} \times 0.02$.
Col. (5) = Col. (2) − $\sqrt{\text{Pitch}} \times 0.01$.
Col. (6) = Standard Pitch Diameter − $\sqrt{\text{Pitch}} \times 0.01$.

are also given in Table VI, in column 6.

The maximum and minimum limit diameters for machine screw taps, measured at the top of the thread, are given in Table VII.

The maximum limit is determined by the formula

Max. Limit = Min. Tap OD. + $\sqrt{\text{Pitch}} \times 0.016$.

These limits are given in column 6 of above table.

The Minimum Limit equals Basic Standard (0.10825) OD. + $\sqrt{\text{Pitch}}$ 0.005 + P. The maximum and minimum limit diameters for machine screw taps, measured at the top of the thread, are also given in Table VIII, cols. (d) and (a) respectively, with the formulas for them, below the table.

Columns (c) and (f) give the excess of minimum and maximum pitch diameter of standard machine screw taps over the pitch diameter of basic standard. These values will readily determine the correct size, within the limits recommended, of machine screw taps, using a micrometer fitted with spherical contacts and measuring in the angle of the thread, in comparing the diameter of taps with the reference standard gauges.

LIMITS OF VARIATION IN SCREW AND TAP PITCHES.

As screws and taps are likely to have errors of pitch or lead, this variation must be taken into consideration. To make proper allowance for this, due to changes in the lead of thread in the dies used for threading screws, and of taps in hardening, it has been determined by your committee that for screws this allowance shall not exceed 0.004 inch, either plus or minus the standard gauge, per inch of length of thread of screw.

For machine screw taps, this allowance, under advisement by representative manufacturers of taps, can reasonably be stated as 0.015 inch, plus or minus the standard pitch, per inch of length of tap thread.

The limits of variation for threads of taps, measured in the angle of the thread, as given in Table VI, have accordingly been based upon this allowance. The plus amount in diameter of minimum taps, given in column (c), Table VIII, is thus the excess above the pitch diameter of the corresponding basic standard, by the amount necessary to permit the maximum screw to enter a tapped hole made by a minimum tap. This is also governed by the thickness of the templet thread gauge for each. This dimension for each size machine screw being given in Table IX.

To facilitate the work of establishing the necessary threading tools for the accurate production of basic and reference standard thread gauges, Table X is given, as the accuracy of the width of flat, both at top and at bottom of the thread, together with the correct angle of 60 degrees, is particularly important in determining the exact pitch diameter of these standard basic and reference gauges.

To present graphically, on an enlarged scale, the clearance, top and bottom of the thread, with the limit of variation between screw and tapped hole, the thread diagram here given, Fig. 4, on a scale of 10 inches pitch, shows in a marked degree, even though reduced to about one-half, the relative limits, top and bottom, and in the angle of the thread, with the clearance at top and bottom of the thread resulting from the variation between maximum tap and minimum screw, recommended by your committee.

The variation, plus and minus, for tap

TABLE VI.

LIMITS OF VARIATION FOR DIAMETERS OF MACHINE SCREW TAPS.
(Measured in the Angle of the Thread.)

Minimum Limit=Pitch Diameter for Standard Taps (Col. 3, Table II.)
Maximum Limit = $\sqrt{\text{Pitch}} \times 0.008$.
Maximum Pitch Diameter = Maximum Limit + Pitch Diameter of Standard Tap.

Standard Diameter.	Number of Threads per Inch.	Pitch of Thread. $\left(\frac{1}{n}\right)$	Pitch Diameter Minimum Taps.	Pitch Diameter Maximum Taps	Maximum Limit $\sqrt{\text{Pitch}} \times 0.008$.
(1)	(2)	(3)	(4)	(5)	(6)
0.070	72	.013889	.06157	.06251	.00094
0.085	64	.015625	.07548	.07648	00100
0.100	56	.017857	.08907	09014	.00107
0.110	48	.020833	.09719	.09834	.00115
0.125	44	.022727	.11099	.11220	00121
0.140	40	.025000	.12455	.12582	00127
0.165	36	.027778	.14779	.14912	00133
0.190	32	.031250	17058	.17199	00141
0.215	28	.035714	.19275	.19426	00151
0.240	24	.041667	.21396	.21559	00163
0.250	24	.041667	.22396	.22559	00163
0.270	22	.045455	.24155	.24326	.00171
0.320	20	.050000	.28864	29043	00179
0.375	16	.062500	.33566	.33766	00200

NOTE.—Col. (4) = Standard Pitch Diameter + ($\sqrt{\text{Pitch}} \times 0.005$).
Col. (5) = Col. (4) + ($\sqrt{\text{Pitch}} \times 0.008$).

and screw, wholly plus for tap and minus for minimum screw for the basic standard is also clearly represented by the diagram. The data included thereon will show the range of limit variation found desirable by your committee for practical interchangeability.

Fig. 5 shows the relative proportions of sharp "V," U. S. and basic standard screw and tap standard, with screw and tap limits. Fig. 6 shows the condition of a standard screw fitting a standard tapped hole, while Fig. 7 exhibits the condition of greatest variation between them, including outside diameter, pitch diameter and error in lead of screw thread. Fig. 8 shows the method of calibration recommended, using a spherical contact micrometer for the purpose of comparing reference gages with the basic standard thread gages, or working gages with the standard reference thread gages.

This method *only*, can be relied upon for accuracy required, and is especially adapted for duplicating thread diameters and for determining variations from the standard gages in the angle of the thread. It is an imperative condition, however, that the thread angle of all gages, screws and taps be 60 degrees.

STANDARD PROPORTIONS FOR MACHINE SCREW HEADS.

Through their courtesy and the interest taken in the matter of a standard for machine screws by the manufacturers represented at the joint meeting referred to, Tables XI, XII, XIII and XIV, showing details of standard proportions for round head, flat fillister head, oval fillister head and flat head machine screws are here presented, forming a part of the report of your committee.

With each table the formulas are given, covering every detail required for establishing standard heads for the fourteen sizes machine screws considered and recommended by your committee. As will be noted, these specifications are all based upon the diameter of the screw, thus reducing the calculations for each to its simplest form.

In conclusion, your committee desires to record its appreciation of the courtesy and interest shown and assistance rendered by the representative screw manufacturers, which has thus made it possible for your committee to complete its work.

Your committee also wishes to acknowledge its obligation to Mr. J. M. Carpenter, President the J. M. Carpenter Tap and Die Company, Pawtucket, R. I., and to Mr. F. G. Echols, Manager Small Tool Department, Pratt & Whitney Company, Hartford, Conn., for valuable information relating to machine screw taps, which has been included in the determination of the various limits for taps, recommended as necessary in this connection for securing practical uniformity, and consequent interchangeability.

TABLE VII.

LIMITS OF VARIATION FOR EXTERNAL THREAD DIAMETERS OF MACHINE SCREW TAPS.

Minimum Diameter = Standard Diameter + $\sqrt{\text{Pitch}} \times 0.005 + \text{Pitch} \times (0.10825)$. (See Col. 1, Table II.)

Maximum Diameter = Minimum Tap Diameter + $\sqrt{\text{Pitch}} \times 0.016$.

Standard Diameter.	Number of Threads per Inch.	Pitch of Thread.	Minimum Diameter.	Maximum Diameter.	Maximum Limit $\sqrt{\text{Pitch}} \times 0.016$.
(1)	(2)	(3)	(4)	(5)	(6)
0.070	72	.013889	.07209	.07397	.00188
0.085	64	.015625	.08732	.08932	.00200
0.100	56	.017857	.10260	.10474	.00214
0.110	48	.020833	.11298	.11529	.00231
0.125	44	.022727	.12821	.13062	.00241
0.140	40	.025000	.14350	.14603	.00253
0.165	36	.027778	.16884	.17151	.00267
0.190	32	.031250	.19427	.19710	.00283
0.215	28	.035714	.21981	.22283	.00302
0.240	24	.041667	.24553	.24880	.00327
0.250	24	.041667	.25553	.25880	.00327
0.270	22	.045455	.27599	.27940	.00341
0.320	20	.050000	.32653	.33011	.00358
0.375	16	.062500	.38302	.38702	.00400

TABLE IX.

THICKNESS OF TEMPLET THREAD GAUGES FOR INSPECTION OF MACHINE SCREWS.

(Thickness = $\sqrt{\text{Pitch}} \times 1.443$.)

Standard Diameter.	Threads per Inch.	Thickness.
0.070	72	0.170
0.085	64	0.180
0.100	56	0.193
0.110	48	0.208
0.125	44	0.217
0.140	40	0.228
0.165	36	0.240
0.190	32	0.255
0.215	28	0.273
0.240	24	0.295
0.250	24	0.295
0.270	22	0.308
0.320	20	0.323
0.375	16	0.361

TABLE X.

PROPORTIONS OF MACHINE SCREW STANDARD THREADS.

(For Reference, in making Threading Tools for Standard and Working Gauges.)

Diameter and Threads per Inch.	Pitch, $\left(\frac{1}{n}\right)$	Width of Flat, $\frac{1}{8}$ Pitch.	Width of Flat, $\frac{1}{9}$ Pitch.	Depth U. S. Thread.	Depth Machine Screw Thread.	$\frac{2}{3}$ (Depth) U. S. Thread.	$\frac{2}{3}$ (Depth) Machine Screw Thread.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
0.070—72	.013889	.001736	.000868	.00902	.00977	.01804	.01954
0.085—64	.015625	.001953	.000977	.01015	.01099	.02030	.02198
0.100—56	.017857	.002232	.001116	.01160	.01257	.02320	.02514
0.110—48	.020833	.002604	.001302	.01353	.01466	.02706	.02932
0.125—44	.022727	.002841	.001421	.01476	.01599	.02952	.03198
0.140—40	.025000	.003125	.001563	.01624	.01759	.03248	.03518
0.165—36	.027778	.003472	.001736	.01804	.01955	.03608	.03910
0.190—32	.031250	.003906	.001953	.02030	.02199	.04060	.04398
0.125—28	.035714	.004464	.002232	.02320	.02513	.04640	.05026
0.240—24	.041667	.005208	.002604	.02706	.02932	.05412	.05864
0.250—24	.041667	.005208	.002604	.02706	.02932	.05412	.05864
0.270—22	.045455	.005682	.002841	.02952	.03198	.05904	.06396
0.320—20	.050000	.006250	003125	.03248	.03518	.06496	.07036
0.375—16	.062500	.007813	.003907	.04060	.04398	.08120	.08796

NOTE.—The formulas given in Tables II-IX, inclusive, for limits and other data required, are also applicable for establishing the reference gauges for machine screws of any desired diameter or pitch of the thread, as well as for screws of the diameters given in Table I, which are different in pitch, and therefore SPECIAL in their character; the thread in all cases being U. S. Form, with the modifications of flat at top for taps, and at the bottom for screws being based upon the pitch of the thread in the same proportion.

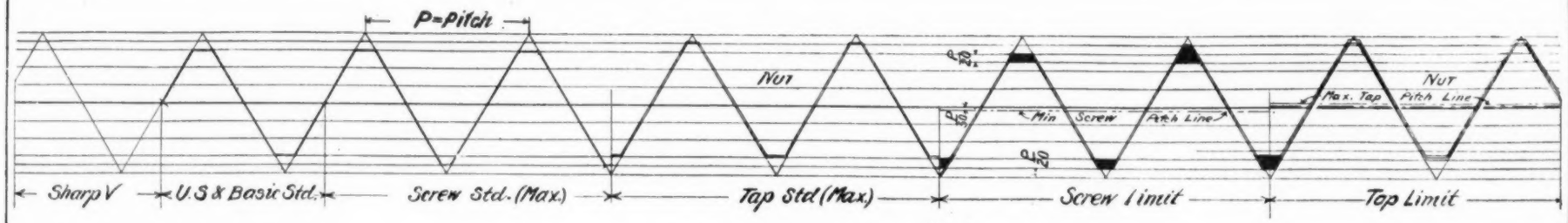
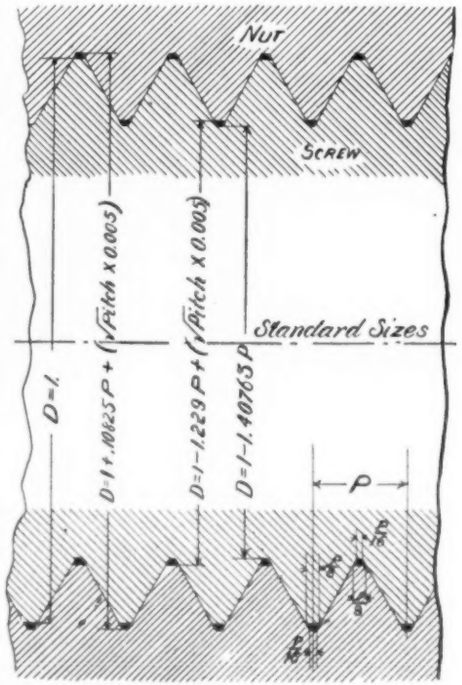


FIG. 5



D=Diameter
P=Pitch

FIG. 6.

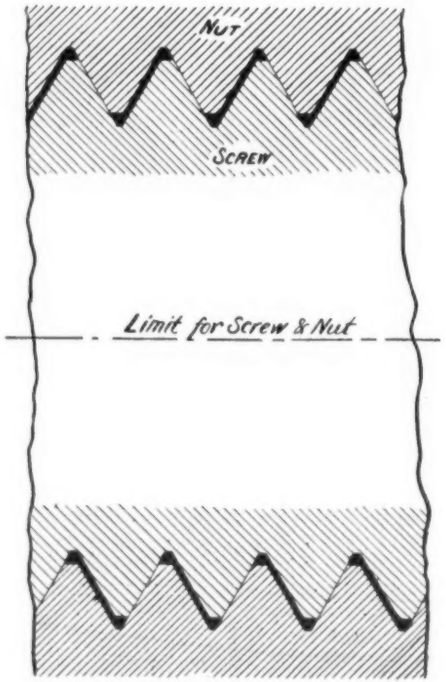


FIG. 7.

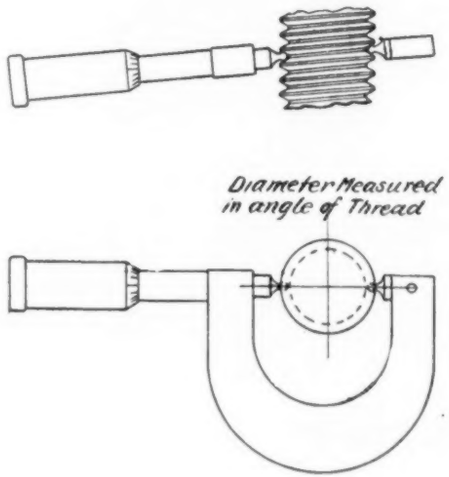


FIG. 8.

PROPORTIONS OF SCREW THREADS.

ENGINEERING REMINISCENCES*

The Summit Reached and the Downward Slope Begun—Hampered by Lack of Capital and Poor Business Judgment—A Treacherous Patent Expert Nearly Ruins the Business—The Engine Adapted to Every Need—Vindicated

BY CHARLES T. PORTER

The more rapid rolling was found to possess advantages beyond the merely increased output. It insured a uniform excellence in the product, which couldn't otherwise be attained even by the utmost care, and it effected several important economies.

BLOOM CHIPPING NO LONGER NECESSARY.

Mr. Jones had recently completed and put in operation a new blooming train, then the largest in the world, for which the size of the ingots to be rolled was increased from 12 inches square to 17 inches square at the base, and the capacity of the Bessemer converters was increased in the same proportion. The output of this mill was much greater than the rail train could dispose of, and a large pile of cold blooms had accumulated in the yard. A force of about 30 men was employed in chipping out all defects in these blooms, which might cause rails to be classed as "seconds."

After my engine had been started it was soon observed that between the shorter time of exposure and the greater rapidity with which heat was imparted to the rails by the rolling, the original heat of the blooms was maintained to the end of the process, every defect was welded up and a perfect rail was produced, so the chipping of the blooms was no longer necessary.

BEGINNING OF THE CONTINUOUS HEAT FOR INGOTS.

It was not a great while before the accumulation of the blooms in the yard was disposed of and the hot blooms were brought directly from the blooming mill. These, of course, were more readily reheated, and moreover, to the surprise of the workmen, less power was required to roll them, and the rolls endured much longer without needing to be re-turned. The explanation was that the cold blooms had never been thoroughly heated in the middle. This was the beginning of maintaining the original heat of the ingot which has since been turned to such great advantage.

THE HIGHEST SUCCESS.

I had now reached the top of my engineering career; I had devoted myself for twenty years to the development of the high-speed engine and to the study of the best means and method of its manufacture, and had introduced into it designs and workmanship of an excellence before unknown in steam-engine construction. I had solved all the theoretical problems involved in the running of high-speed engines, and, starting from Mr. Allen's inventions, of the single eccentric link, and four-opening balanced valve with the adjustable pressure plate, and my governor, had designed every constructive feature and detail of this engine.

I had been for four years carrying on the business of the manufacture of these engines in my own name as sole proprietor but, as already stated, without a cent of capital. I had in this time built between forty and fifty engines of every size on my list, from the smallest to the largest except two; the 44-inch diameter cylinder having been added after my time. Considering my business as an organization, I had been president, secretary, treasurer, general manager, chief engineer, inspector and draftsman. At any rate, the duties belonging to all those positions had been performed by me with satisfactory results. I made every drawing, both general and detail, with my own hands, having only the help of a young man who made my tracings, and when he had time helped me with my section lining. At that time blue-printing had not come into use; drawings were made on white drawing paper and were inked in and the tracings were made for the shop; I began to use the blue-print system when I removed to Philadelphia.

Everyone was loyal to me, I could always rely upon my instructions being faithfully followed, so the work ran as smoothly as the engines themselves; we were, however, much hindered by the poor tools we had to use. These were a fair average of American tools at that time, but Mr. Goodfellow and myself estimated their output to average only about one-half that which we expected in our contemplated works. Besides this, I could not establish piece-work prices or introduce any systematic methods. I became gradually swamped with orders. These outgrew the capacity of the Hewes & Phillips works, or of that portion which I could use. Before I left there, besides the four large orders already named amounting altogether to $48,000 f.o.b., without fly-wheels and which could not be handled in these works, I had accepted orders for smaller engines sufficient to bring the aggregate up to $125,000. These latter were more than I could manage alone, so I had arranged to have some of these also made, or partially made, in other shops.

THE DOWNWARD SLOPE.

From this point my path sloped steeply downward to the grave of all my hopes; in about a year and eight months the business had dwindled to practically nothing, and I, as the party responsible for this result, was turned out of the South-

TABLE VIII.

LIMIT DIAMETERS FOR STANDARD MACHINE SCREW TAPS.
(Measured on Top of Thread.)

Standard Diameter and Threads per Inch.	Minimum. Diameter at Top of Thread.	Minimum. Diameter at Root of Thread.	Minimum. Excess Pitch Diameter over Basic Standard.	Maximum. Diameter at Top of Thread.	Maximum. Diameter at Root of Thread.	Maximum. Excess Pitch Diameter over Basic Standard.
	(a)	(b)	(c)	(d)	(e)	(f)
0.070—72	.07209	.05255	.00059	.07397	.05349	.00153
0.085—64	.08732	.06533	.00063	.08932	.06633	.00163
0.100—56	.10260	.07747	.00067	.10474	.07854	.00174
0.110—48	.11298	.08366	.00072	.11529	.08481	.00187
0.125—44	.12821	.09623	.00075	.13062	.09744	.00196
0.140—40	.14350	.10831	.00079	.14603	.10958	.00206
0.165—36	.16884	.12975	.00083	.17151	.13108	.00216
0.190—32	.19427	.15029	.00088	.19710	.15170	.00229
0.215—28	.21981	.16955	.00094	.22283	.17106	.00246
0.240—24	.24553	.18689	.00102	.24880	.18852	.00265
0.250—24	.25553	.19689	.00102	.25880	.19852	.00265
0.270—22	.27599	.21202	.00107	.27940	.21373	.00278
0.320—20	.32653	.25617	.00111	.33011	.25796	.00291
0.375—16	.38302	.29506	.00125	.38702	.29706	.00325

NOTE.—(a) = Standard Diameter + (0.10825 × Pitch) + ($\sqrt{\text{Pitch}}$ × 0.005).

(b) = Standard Diameter − $\left(\frac{1.2990381}{\text{No. Threads per Inch}}\right)$ + ($\sqrt{\text{Pitch}}$ × 0.005).

(c) = Minimum Tap Pitch Diameter − Standard Basic Pitch Diameter. (See Col. 4, Table VI, and Col. 8, Table II.)

(d) = (a) + ($\sqrt{\text{Pitch}}$ × 0.016).

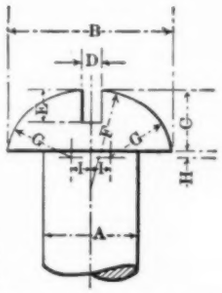
(e) = (b) + ($\sqrt{\text{Pitch}}$ × 0.008).

(f) = Maximum Tap Pitch Diameter − Standard Basic Pitch Diameter. (See Col. 5, Table VI, and Col. 8, Table II.)

TABLE XI.

ROUND HEAD MACHINE SCREWS.

A = Diameter of Body.
$B = 1.83A$ = Diameter of Head.
$C = 0.703A$ = Thickness of Head.
$D = 0.235A$ = Width of Slot.
$E = 0.40A$ = Depth of Slot.
$F = 1.095A$ = Rad. of Top of Head.
$G = 0.70A$ = Rad. of Sides of Head.
$H = 0.068A$ = Dist. from bottom of Head to center of G.
$I = 0.213A$ = Dist. from center of Head to center of G.



A	B	C	D	E	F	G	H	I	Threads per In.
.070	.1281	.0492	.0164	.0280	.0766	.0490	.0048	.0149	72
.085	.1555	.0597	.0200	.0340	.0931	.0595	.0058	.0181	64
.100	.1830	.0703	.0235	.0400	.1095	.0700	.0068	.0213	56
.110	.2013	.0773	.0258	.0440	.1204	.0770	.0075	.0234	48
.125	.2287	.0879	.0294	.0500	.1369	.0875	.0085	.0266	44
.140	.2562	.0984	.0329	.0360	.1533	.0980	.0095	.0298	40
.165	.3019	.1160	.0388	.0660	.1807	.1155	.0112	.0351	36
.190	.3477	.1336	.0446	.0760	.2080	.1330	.0129	.0405	32
.215	.3934	.1511	.0505	.0860	.2354	.1505	.0146	.0458	28
.240	.4392	.1687	.0564	.0960	.2628	.1680	.0163	.0511	24
.250	.4575	.1757	.0587	.1000	.2737	.1750	.0170	.0532	24
.270	.4944	.1898	.0634	.1080	.2956	.1890	.0184	.0575	22
.320	.5856	.2250	.0752	.1280	.3504	.2240	.0218	.0682	20
.375	.6862	.2636	.0881	.1500	.4106	.2625	.0255	.0799	16

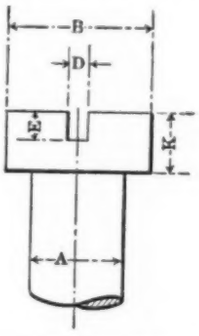
wark Foundry into the street. At the bottom this was entirely my own fault. No one could ask to be associated with a better body of men than were those who united to sink their money in the manufacture of the Porter-Allen engines.

My aim had been to reach a point where I could command the capital necessary to establish my business according to the plan which I had cherished ever since my return from England, but on a much larger scale than I then contemplated. I had now reached that point. Parties who were finding themselves enriched by my engine were ready to pour out their money like water for my use, but there was something else that I needed even more than their money, without which indeed as the event proved, their money was of no use at all. That was their respect for me and confidence in me as a strong business man; my record would have sufficiently justified that confidence, but of this they were ignorant. They had no means to form a judgment of me except what I did then and there. I never thought of this supreme requirement, and in response to their request made them an offer which, regarded from their point of view, appeared so unbusinesslike, that they could form only one conclusion, that while unquestionably I could make engines all right, in matters of business I was a mere baby whose opinion on business matters was not to be regarded seriously.

TABLE XII.

FLAT FILLISTER HEAD SCREWS.

A = Diameter of Body.
$B = 1.6A$ = Diameter of Head.
$K = 0.65A$ = Thickness of Head.
$D = 0.235A$ = Width of Slot.
$E = 0.5K$ = 0.325A = Depth of Slot.



A	B	K	D	E	Threads per Inch.
.070	.1120	.0455	.0164	.0227	72
.085	.1360	.0552	.0200	.0276	64
.100	.1600	.0650	.0235	.0325	56
.110	.1760	.0715	.0258	.0357	48
.125	.2000	.0812	.0294	.0406	44
.140	.2240	.0910	.0329	.0455	40
.165	.2640	.1072	.0388	.0536	36
.190	.3040	.1235	.0446	.0617	32
.215	.3440	.1397	.0505	.0698	28
.240	.3840	.1560	.0564	.0780	24
.250	.4000	.1625	.0587	.0812	24
.270	.4320	.1755	.0634	.0877	22
.320	.5120	.2080	.0752	.1040	20
.375	.6000	.2437	.0881	.1218	16

MY HANDICAPS IN MANUFACTURING.

How came I to do myself, and them also, as the victims of their mistaken judgment, this injustice? My whole life was bound up in the engine; I cared nothing for money except to develop its manufacture; I felt that every dollar paid to myself would leave so much less for this purpose. I asked nothing for the good will of my business, for I was not selling it; they were putting money into my business, which, of course, I would continue to carry on as I had done. This was my mistaken view; I consulted fully with Mr. Hope whose interest was equal with mine, and he viewed the matter precisely as I did. Although standing at the head of his profession as a fire underwriter, he had not the special business training or experience that would enable him to give me the advice I needed, so I told them that if a company should be formed to manufacture the engines with $800,000 capital, I would assign to it my patents for $100,000 of its stock, the value of which I assumed I would increase several fold in a few years. Beyond this I assumed everything and made sure of nothing, so our minds never came together. They could not understand my position. They could not appreciate my sentiment. They were business men, and did business on strictly business principles. What their position was I came to understand later. From the fact that I did not stipulate for it they concluded that I did not expect the presidency of the company but had yielded it to them, which they accepted, of course, in accordance with their general usage that capital takes the direction of a business which it knows nothing about, relying upon skilled experts in its various departments.

RESULT OF AN UNBUSINESSLIKE PROPOSITION.

Thus by my failure to realize their necessary position and to lay before them a thoroughly businesslike proposition, demanding a certain sum for the patents and the good will of the business, assuring to myself its executive management, and the safety and disposition of their money to them, the enterprise was doomed from the start.

THE WORKS.

An excellent opportunity seemed to offer itself for going right on with my business without the delay which would be involved in the erection of new works. The Southwark Foundry was in the market for sale. These were the old engineering works of the firm of S. V. Merrick & Sons; they were famous works before the

war, when they were largely devoted to the manufacture of municipal gas and water plants, having, I think, a monopoly of this class of work, for which they were especially equipped. During the war they had built engines for some government vessels. A few years after the war the elder Mr. Merrick died and his two sons, J. Vaughan and William H. Merrick, retired from business and these works were closed. In company with several of the gentlemen interested I was shown over the works by William H. Merrick and was very favorably impressed with them. They covered a large plot of ground, the front extending from Fourth to Fifth streets on the south side of Washington avenue, in Philadelphia; they were favorably located with respect to transportation facilities; a branch of the Philadelphia & Baltimore Railroad ran through this avenue to the Delaware river and two switches from these tracks entered the works, one going to the foundry and one onto the erecting floor. This floor was commanded by three cranes, the largest I had ever seen, operated by power, while an annex to the foundry was commanded by a steam crane of equal size, and the main foundry floor was provided with an overhead traveler, the only one at that time in the country. The machine shop was a large three-story building, the first and second floors of which, as well as the erecting shop, were filled with tools, some of them of large size. I was particularly impressed by the great planer, the largest in the country, capable of passing objects 12 feet square. The office was provided with a large fireproof vault, which was carried up to the second story for the use of the drawing office.

I expressed myself decidedly in favor of purchasing these works; I could form no judgment respecting the tools, all their working parts being coated with a composition of white lead and tallow; but I did not care much about them, because I should speedily fill the works with the latest improved tools, most of which I expected to import from England. A contract was immediately made for the purchase of these works, in part payment for which the Merrick brothers were to accept stock in the proposed company. Thus they became numbered among our stockholders.

THE FIRST MEETING.

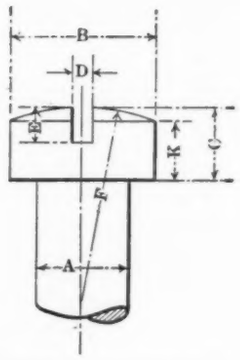
I was next invited to attend a meeting of a few gentlemen to arrange a slate for the action of the subscribers at a meeting which had been called for organization. This first meeting was full of surprises to me. I went into it expecting the gentlemen to say to me: "Of course, Mr. Porter, you will accept the office of president?" quite unconscious that I had made it impossible for them to think of such a thing, but quite conscious that no amateur in that position could by any possibility make the business successful, unless he should commit the management entirely to my hands and content himself with being a mere figurehead.

Mr. Townsend announced that the first question to be settled would be the name of the company. I remarked: "There can be but one name for it: the Porter-Allen Steam Engine Manufacturing Company." Then Mr. William H. Merrick spoke up: "I don't know about that; of course, no one can imagine that the manufacturing of these engines can employ all the resources of these great works; there is a vast amount of work of the character formerly carried on in them which will naturally flow back to them, and I think the door should be left open for its return." I expressed my amazement at such a view; that it must be obvious to any observer that my business only required suitable means for carrying it on to grow to great proportions and the resources of these works, whatever they were, would need to be greatly enlarged for its use, and besides the name ought to describe and advertise the business. When a vote was taken

TABLE XIII.

OVAL FILLISTER HEAD SCREWS.

A = Diameter of Body.
$B = 1.6A$ = Diameter of Head.
$C = 0.80A$ = Thickness of Head (oval).
$D = 0.235A$ = Width of Slot
$E = 0.5C = 0.4A$ = Depth of Slot.
$F = 2.186A$ = Radius of Head.
$K = 0.65A$ = Thickness of Head (flat).

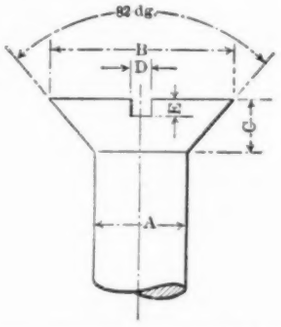


A	B	C	D	E	F	K	Threads per In.
.070	.1120	.0560	.0164	.0280	.1530	.0455	72
.085	.1360	.0680	.0200	.0340	.1858	.0552	64
.100	.1600	.0800	.0235	.0400	.2186	.0650	56
.110	.1760	.0880	.0258	.0440	.2404	.0715	48
.125	.2000	.1000	.0294	.0500	.2732	.0812	44
.140	.2240	.1120	.0329	.0560	.3060	.0910	40
.165	.2640	.1320	.0388	.0660	.3607	.1072	36
.190	.3040	.1520	.0446	.0760	.4153	.1235	32
.215	.3440	.1720	.0505	.0860	.4700	.1397	28
.240	.3840	.1920	.0564	.0960	.5246	.1560	24
.250	.4000	.2000	.0587	.1000	.5465	.1625	24
.270	.4320	.2160	.0634	.1080	.5902	.1755	22
.320	.5120	.2560	.0752	.1280	.6995	.2080	20
.375	.6000	.3000	.0881	.1500	.8197	.2437	16

TABLE XIV.

FLAT HEAD SCREWS.

A = Diameter of Body.
$B = 2A - 0.0052$ = Diameter of Head.
$C = \dfrac{A - 0.0052}{1.739}$ = Thickness of Head.
$D = 0.235A$ = Width of Slot.
$E = \frac{1}{3}C = \dfrac{A - 0.0052}{5.217}$ = Depth of Slot.



A	B	C	D	E	Threads per Inch.
.070	.1348	.0373	.0164	.0124	72
.085	.1648	.0459	.0200	.0153	64
.100	.1948	.0545	.0235	.0182	56
.110	.2148	.0603	.0258	.0201	48
.125	.2448	.0689	.0294	.0229	44
.140	.2748	.0775	.0329	.0258	40
.165	.3248	.0919	.0388	.0306	36
.190	.3748	.1063	.0446	.0354	32
.215	.4248	.1206	.0505	.0402	28
.240	.4748	.1350	.0564	.0450	24
.250	.4948	.1408	.0587	.0469	24
.270	.5348	.1523	.0634	.0508	22
.320	.6348	.1816	.0752	.0605	20
.375	.7448	.2126	.0881	.0709	16

every man voted for the historic Philadelphia name of the "Southwark Foundry," to which they added "and Machine Company," and I discovered that my views had no weight at all. I had afterward the pleasure of being asked by my friends occasionally, what good I supposed that name would do my business?

The next subject was the election of a president, and my next discovery was that I was not even thought of. If anyone had been asked why he had not thought of me he would very properly have replied that "to commit the interests of this company to a man who had shown so little ability to look out for his own interests did not impress him favorably." Every vote was cast for William H. Merrick, and I was elected vice-president, with charge of the manufacturing.

A day or two after, the meeting was held which had been called for the purpose of hearing the report of the patent expert and organizing the company. At this meeting the expert was not prepared to report, as an application for the reissue of an important patent was still pending. Mr. Merrick moved that a temporary organization be then effected, so that we might proceed at once with work on pressing orders. On my assurance that this reissue was certain to be allowed, the motion was adopted and a temporary board of directors was elected, Mr. Merrick and myself were elected president and vice-president, respectively. Mr. Merrick told me afterward that he made the motion because he knew that those 21 gentlemen there assembled could never be got together again if this meeting should prove fruitless.

GETTING TO WORK.

The directors held a meeting immediately after, and at this meeting I presented a letter which I had written to the chairman of the meeting called for organization, setting forth the requirements of the engine for the latest and most improved tools and asking for an immediate appropriation of $100,000 for their purchase, as time was of the utmost consequence. To this Mr. Merrick replied that such action would be entirely unnecessary, saying: "I assure you, gentlemen, and I assure Mr. Porter, that for a long time to come he will find in these works everything he can possibly desire." Of course I could make no reply to this positive statement, and the matter was dropped. We immediately took possession of the works and a large force of men was put at work cleaning the tools and getting them in working order; I also had my drawings, patterns and all work in progress brought from Newark and from all shops where it had been commenced. Prominent among these latter were the bed, cylinder and shaft of the first of the 40x48-inch engines which were then ready for finishing.

NO FIT TOOLS.

In about two weeks from the date of this meeting Mr. Goodfellow came into the office pale and trembling with excitement, and addressing himself to me, Mr. Merrick sitting on the opposite side of the table, said: "Mr. Porter, I give it up; we might just as well be set down in a cotton mill to make steam engines; there is not a tool in the place that has not spoiled every job that has been put in it, from the day we came here. I don't believe another such lot of antiquated and worn-out rubbish exists on the face of the earth." This was not news to me, as I had spent much of my time in the shop. Our most serious disappointment was the condition of the great planer; we had hurried the above mentioned engine bed on it as soon as it arrived, and when it had been planed the surface plate was laid on the guide bars, which were 7 feet 6 inches long, and it was found to rock on two diagonal corners nearly an eighth of an inch, showing a cross-wind of over half an inch in the whole length of the planer bed; this of course rendered the tool useless in its present condition. I had found that the means for boring the 40-inch cylinder and for finishing the shaft, as well as for doing the other work for this engine, were all equally useless, and I proposed to Mr. Merrick that these parts should all be sent back to the shops from which they had been brought and finished there, and the engine altogether built in outside shops, just as I had built the first one. This he flatly refused to do, saying he would not make such an exposure of our condition. Our plight may be understood when I state that it was over a year before we could deliver that first large engine, although every effort was made to complete it, the castings and forgings waiting for many months.

But, exclaims the reader, "Why, when this state of affairs was first discovered, were not steps instantly taken to remedy it?" The answer to this question involves a very different subject. When I had received in Newark a letter from Mr. Merrick requesting me to send on my patents for examination by an expert, I was suddenly reminded that I had omitted to obtain the reissue of the latest patent which Mr. Allen had obtained, namely, the one for his adjustable pressure plate, which had been so shockingly muddled by the Washington agent of the patent solicitors that when we received it we could not understand the specification and the claims were absolutely meaningless. However, I had said to myself, there will be time enough to have it reissued when it becomes necessary, as applications for reissue are always passed upon immediately. Before sending the patents on, however, I prepared myself a new and clear specification for that patent and put it in my pocket.

THE TREACHEROUS PATENT EXPERT.

In two or three days I followed the patents to Philadelphia and met the patent solicitor; he told me all the patents seemed to be well enough except this one, and this he could make nothing out of. I told him how that came to be such a muddle, that I always intended to get it reissued, and now would employ him to do it. I produced the amended specification I had prepared for that reissue; he read it and handed it back to me, saying it would be of no use to him. I instantly thought of the protest of Mr. Perker: "Really, Mr. Pickwick, really, my dear sir, when one places a matter in the hands of a professional man he must not be interfered with; indeed, he must not, my dear sir, really." I made an humble apology for my presumption, but asked him if he would get the application in next day at farthest, that the reissue might be received in time for him to report on it at the meeting called for the organization of the company, then some days distant. He made no reply. I soon found I had fallen into the hands of a traitor, who intended to use his professional power to strangle my enterprise in its birth, and who never did give up his prey until it was torn from his fangs.

Not hearing from him for a day or two, I called to see what was the matter, and was stunned by his telling me that he had determined not to apply for a reissue, but to report against me on the patent as it stood, saying that a reissue could not be got, and if it was it would be good for nothing. I attempted to argue the matter with him, but found him firm. I then went directly to the office of Morgan & Lewis, the attorneys for the company, and told the story. Mr. Morgan said: "I will go and see him at once;" so we went together. The expert repeated his determination to Mr. Morgan, and, anxious that the latter should understand the merits of the case, I presented it to the expert as plainly as I knew how, Mr. Morgan being an attentive listener. Many months afterward I realized the vital importance of the lesson I then gave to Mr. Morgan. The expert persisted in his determination, but consented to see Mr. Morgan again the next day. On our way back I said to Mr. Morgan: "It seems to me that this man does not see the point of the application because he won't see it; he doesn't want to see it." Mr. Morgan made the rather enigmatical reply: "It seems very plain to me."

The next day Mr. Morgan made the point to the expert that he could not afford to take such a position as that—he could not sustain it. He then consented to make the application, but added what he had already said to me, that he had no idea it would be granted, and if it was, it would be good for nothing. It will hardly be credited that he was over four weeks in preparing this application, getting it into a form in which he was sure it could not be allowed. When it was finally shown to me I could not understand it. It contained two references, the pertinence of which I could not see; he

assured me, however, that it was the very best that could be done, although he said he had very little hope that it would be allowed. Sure enough, in a few days the rejection was received from Washington and a meeting was called to hear his report. He used very strong language in making his report, saying: "This rejection is final and the case is hopeless," and, walking over to where I was sitting, he shook a paper in my face with an air as if I had been a detected felon and he held in his hand the proof of my rascality, saying: "This is a paper I received from Washington this morning that settles your hash, sir." When he sat down the silence might have been felt. Everyone shrank from what appeared to them the inevitable and final step, the adoption of a resolution to the effect: "Whereas Mr. Porter has failed to keep his agreement with us, the whole matter be now dismissed from our further consideration."

THE STRIFE FOR A REISSUE.

I did not allow them much time for reflection, but rose and made a little speech, as follows: "Mr. Chairman, I have but a single word to say; I have taken this matter out of the expert's hands; I expect to go to Washington tomorrow morning and return in the afternoon, and when I come back I shall bring this reissue with me." No one said a word, but I knew what was in every man's mind: "What a fool, when our great Philadelphian authority has spoken, to imagine that *he* can do anything to change the result." However, there was no disposition to cut me off by any precipitate action, and the meeting adjourned subject to the call of the chair, everyone feeling that it was a mere waste of time.

The next morning I was received by Mr. Fowler, the accomplished chief examiner in the class of steam engines, with his usual extreme courtesy. He told me that he felt extremely sorry at finding himself obliged to reject my application, but the very precedents cited in the application itself left him no alternative. "However," he added, "if you have anything new to present, I shall be most happy to receive it." In reply I handed to him the specification which had already done duty so ineffectively with the expert, and in which I had not changed a syllable. He read it through with fixed attention, and the instant he finished he exclaimed: "Why, Mr. Porter, it is perfectly obvious that you are entitled to this reissue, and the cases cited in the application have nothing to do with it; but why was not this presented to me in the first place?" I told him I had prepared it for that purpose and placed it in the hands of the expert, who, after reading it, returned it to me, saying it would be of no use to him. He instantly asked me if I had prepared any claims. I told him I had, because I could not get anyone to prepare them for me; but it was a new business to me and I asked the advice of the expert about them, who, after reading them, returned them to me without any suggestion, merely remarking: "If you get these allowed, you will be doing very well." The moment Mr. Fowler glanced at them he exclaimed: "Oh, Mr. Porter, we cannot allow any such claims as these; they are functional claims, which the Patent Office never allows." Then, evidently seeing my helpless condition in the hands of a traitor, he instantly added: "I shall be occupied this morning, but if you will call at 3 o'clock, I will have two claims prepared for you which will be allowed." So the expert let me go to Washington with claims that he knew could not be allowed, and sure that my errand would be fruitless. But he did not imagine that the examiner would see through his treachery and thwart it. At 3 o'clock our interview was brief; as I entered Mr. Fowler's room he handed me a paper, saying: "These have been allowed; you will receive the reissue in the course of three or four days, and it will appear in next week's *Gazette*. Good afternoon."

I suppose that I never looked on a countenance expressing more amazement than did that of Mr. Merrick when next morning I handed him the copy of the claims and told him my brief story. He said he could hardly believe his senses. Taking the paper, he started for Mr. Townsend's office, and in the course of an hour all the parties in interest had been apprised of my easy triumph. The reissue arrived as promised, was placed in the expert's hands, and a meeting was called to receive his report. I thought my troubles were all over, the case was an absolutely simple one, there was no pretense that the invention was not new and he must report in its favor, no matter how reluctant he might be to do so. What was my amazement and fury when he quietly stated to the meeting that he had no report to make, that the case involved very serious questions which would require much time for their consideration; that the granting of the patent was nothing—it was the business of the patent office to grant patents, not to refuse them, but whether or not they would be sustained by the courts was entirely another matter about which in this case he had very grave doubts.

I now did what I never did before or since and what no good business man, who is accustomed to accomplish his purposes, ever allows himself to do; I, who always prided myself on being destitute of such a thing, lost my temper. Already driven frantic by the frightful condition of affairs at the works, which had been protracted six weeks by this man's machinations, and which he threatened to continue indefinitely while he should endeavor to find some means to accomplish his purpose of wrecking my business, without an instant for reflection I shouted: "You rascal: what was the Patent Office doing a week ago when you reported to these gentlemen that this reissue had been refused, that the decision was final and the case was hopeless; what were they doing then, I would like to know? Were they granting patents or refusing them? The fact is you are either a traitor or know nothing about your business, and you may hang on either horn of the dilemma you like," and I sat down, having in these few seconds done myself and my case more harm than everybody else could have done in a lifetime. I did not reflect that I could not have the sympathy of my audience; they knew nothing of the state of affairs at the works nor of the consistent course of treachery which this man had been following. All they could see was that I had used outrageous language for which they could not imagine any justification toward an eminent patent lawyer who enjoyed their confidence, and they naturally supposed that was my usual way of doing business. The chairman coldly informed me that the lawyer was their patent adviser and nothing whatever could be done until his report on the reissue should be received. The reader will not be much surprised to learn that it was four months longer before we heard from him again—four months of frantic helplessness.

About the first of July I called at the expert's office and was informed that he had gone on his vacation and would be absent about six weeks, and the case could not be taken up until his return. In my desperation I called upon Mr. Townsend and made to him a clean breast of our helpless condition and offered to pledge all our stock as security for a loan of the money necessary to buy a few of the most indispensable tools. He replied to me: "Suppose the report of the expert shall be adverse and the enterprise be abandoned, what do you think your security will be worth?"

ONE BRIGHT SPOT IN THE GLOOM.

I succeeded in saving one order from the wreck in rather a singular manner. This was an order from Mr. Lewis, of Cincinnati, the projector of the cotton-seed oil business, for an 18x30-inch engine to drive the machinery of their first oil mill at Houston, Texas. I had built in Newark an engine of the same size for Senator Jones, of Nevada, to drive an ice-making plant which he was establishing in the city of New Orleans. Word came to me some time that spring that this enterprise had proved a failure, the work had been abandoned and the engine, their only asset of value, was for sale. I instantly bought it and sent a man down to transport it to Houston and erect it there. Mr. Lewis wrote me from Cincinnati an indignant letter at my sending him a second-hand engine. I replied to him, stating first it was my only possible way of filling his order at all as I did not know when we should be able to build an engine in our new works and second that it was a new engine, having been run only a few weeks, long enough to show its excellent condition and not

so long as engines are often run in public exhibitions from which they are always sold as new. Mr. Lewis gracefully accepted my explanation and the engine was in readiness for them to grind the coming cotton-seed crop. The next year we had a call from the agent of that mill who had come north during their idle interval while they were waiting for their next crop, to make his report at Cincinnati and had come out of his way to tell us of the wonderful manner in which that engine had carried them through their first season, which be concluded by saying: "That is the engine for the cotton-seed oil business." After he had gone I said to Mr. Merrick: "That is an old story to me; everybody says that is the engine for their business, whatever their business happens to be."

A NEW SYSTEM OF KEEPING DRAWINGS.

What did I do with myself during that six months? Well, I was not altogether idle. First I found all the drawers in the drawing office filled with piles of old drawings which Mr. Merrick ordered to be preserved and which we piled up on the floor of the unoccupied third story. Out of the contemplation of that confused heap I evolved a new system of making and keeping mechanical drawings which I described in a paper read the next year before the American Society of Mechanical Engineers.*

Twenty-five years afterward I visited the Southwark Foundry, and was shown over the works by Mr. Brooks, the president. I was filled with wonder and delight at the resuscitation and development of the business which had been effected by this remarkable man. The only thing he told me respecting their system was: "We make a separate drawing of every piece." I employed myself also in devising some new tools, but the description of these will be left until the next paper.

MY VINDICATION.

The whole summer passed, many had taken trips to Europe and back, when about the middle of September Mr. Morgan notified the chairman that he had received the expert's report and requested him to call a meeting of the subscribers to hear it; I went to the meeting with mingled hope and apprehension. Mr. Morgan read a long letter from the expert containing an elaborate argument against the patent and concluding by saying that he could not recommend its acceptance. When Mr. Morgan had finished reading the letter he continued right on: "Mr. Chairman, I am tired of this man's delays and quibbling, and I now advise you that Mr. Porter has performed his contract and it only remains for you to perform yours." This was the harvest from the seed I had sown six months before. Mr. Morgan's advice was received by the meeting with a feeling of relief from a long suspense; it was at once accepted unanimously and the temporary organization was made permanent. The directors immediately convened.

Before proceeding to the transaction of business one of the directors said to me: "Mr. Porter, you have now been in the Southwark Foundry for six months and I understand that not a single engine has been sent out from that place in all that time; will you tell us why this is so?" I had then an opportunity of witnessing a nobility of soul such as few persons meet with in the whole course of their lives. Mr. Merrick rose and said: "I will save Mr. Porter the trouble of answering that question. Mr. Porter has not sent a single engine out of these works because he has not had a single tool with which he could make an engine. I thought I knew all about those tools when last March I assured you and Mr. Porter he would find everything he could possibly desire, when the fact was I knew nothing about them. I have been through those tools carefully with Mr. Goodfellow and have seen for myself that not one of them could produce work fit to be put in those engines. While I am about it I wish to make another confession: I said then, and you all agreed with me, that it could not be expected that the mere manufacture of these engines could employ all the resources of that great establishment and so we left the door open for the return to it of the class of work which had formerly occupied it; but from what I have myself seen in the six months I have been there I am able to say to you that if the works had possessed the resources which I really believed it did possess, they would have been insufficient to meet the demands for these engines which have come to us from all parts of the country and for many different kinds of business. Mr. Porter knew what he wanted and the demand that might reasonably be expected; I had no conception of the one or the other. It is a great pity that we did not then give him the means he asked for, and I hope this will be done now."

Mr. Henry Lewis spoke up and said: "What did Mr. Porter ask for? I have no recollection of his asking us for anything at all." None of the directors could remember anything about it, the letter which I had addressed to the chairman had even disappeared. Luckily, however, I had made a copy of it and I produced the letter-book in which it was the first letter copied and read them this copy. I should say here that I have inquired at the works for this letterbook, but have been told by Mr. Brooks, the president, that all correspondence more than 20 years old having no legal value had been destroyed. When I had finished Mr. Lewis exclaimed: Did you write that letter?" "I did sir," I replied.

"Well" he said, "I suppose I must have heard it, but I have not the faintest recollection of it." All said the same thing except Mr. Merrick, as it had brought out his reply.

This illustrates the indifference of the directors at that time to anything that came from me. An earnest disposition was manifested to make all the amends possible; the $100,000 which I had asked for was immediately appropriated. In view of the utter barrenness of the works I was asked if it had not better be made $200,000 but this I did not favor. I told them I would rather proceed more slowly, especially as many of the old tools might be made serviceable when we should have perfect tools with which to refit them. So at last I had triumphed at every point. But at what a cost; oh! what a cost.

*Vol. II, Transactions A. S. M. E., page 375.

British Weights and Measures Association

We have at hand the second annual report of the British Weights and Measures Association, of 25 Victoria street, London, S. W. This has, of course, been prepared by the secretary of the association, George Moores, whose work in opposition to the introduction of the metric system in Great Britain and in favor of the decimalization of British weights and measures has previously been referred to. In the present report Mr. Moores says:

While we are not slacking our efforts to oppose the meter, we are not unmindful of our further object to "standardize and simplify British weights and measures." To that end our present policy may be expressed in the words of a resolution passed at one of the executive meetings: "That the recognized policy of the association for the present be one of opposition to the metric system and of investigating and collecting data to be eventually considered by a convention of English-speaking peoples."

Such a convention or commission, or whatever it may be termed, should have not only the Colonies and India represented upon it, but the Crown Colonies also, and the United States of America. We have already gathered much information to place before such a commission, and we welcome the assistance of anyone in any part of the world who can help in that direction. Such a commission as foreshadowed must have the benefit of all the information that can possibly be gathered together on the subject, for if any change is to be recommended to English-speaking peoples it must be a change to the best system that can be devised. On such a commission, moreover, the various interests involved must be properly represented. It will not do for astronomers to prescribe for engineers, nor teachers of physics to tell cotton spinners what their "counts" must be.

CORRESPONDENCE

Discussing Phases of Machine Design and Construction

Independence of Thought and Action — Environment of Apprentices—Second-hand vs. New Machine Tools

If I find incentive in Mr. Plaisted's article at page 240 to add to or explain other things that have appeared in the AMERICAN MACHINIST from my pen, it is to be hoped that your readers will not imagine that he and I spend our time scratching each other's craniums for ideas. I do not wish to be given too much credit for having built a home for myself, but if there is any credit for my nerve I will pass it along to Mrs. Entropy, for I realize only too well that the fair sex is more apt to be influenced by the desire for society than our own. But I have no desire to pose as a reformer. It keeps me too busy just to get a living to leave me any time to try to get other people to follow my lead. Again we are not indifferent to what our neighbors will think, only we prefer to choose which of our neighbors shall have an influence on our actions. Our neighbors across the way may think what they please and we will not budge a hair. But what our neighbor Plaisted thinks is a matter of import to us. To be sure I have not the slightest suspicion where neighbor Plaisted lives, but he cannot live any farther off than some of our other neighbors do for whose opinions we care. Then, once more, none of my neighbors do care anything about what I am doing. They do not know either. I am writing from a part of New England where you may live in a flat for years and have no more knowledge of the other dwellers in the same building than a general idea of how often they cook onions. If you are "anybody" you shut up the flat sometime after April first and put a line in the paper to the effect that Mr. and Mrs. So and So have gone to their summer home in Blank. Then at the end of the summer, say between September first and April first, you return and put a corresponding line in the paper. What happens in between no one knows or cares. Those who stay at home envy you. They may suspect that you live in a dugout, but they envy you just the same.

But the point is this: I believe that the full emancipation of the American people and especially the working people will come only with the ability and the willingness of the "common people" to think for themselves and act accordingly. The ability we can help by education. The willingness we can hope may follow the ability.

Mr. Plaisted is a bit fearsome that I may think that the apprentice boy of the "Good old times" had a better chance than he has today. That opens up a large question, one that cannot possibly be settled, and one that I would rather not take either side of, but on the question of the environment of the latter-day boy and its effect on him I believe that Mr. Plaisted will agree with me that the *average* machine-shop employee of today does not have so high a social standing as the average employee of the days when hand work was in vogue. This does not mean that the true journeyman machinist of today is any better or worse than of old, but that the advent of automatics and repetition work has brought in a lot of men who pull down the standing of the average. And in the days gone by every man inside the shop walls at least hoped some day to start off as a journeyman. The moral force of this condition alone is a matter worthy of consideration, and is one of the things that leads me to the advocacy of trade schools. Where every man within the walls of a shop is working for his own improvement there is bound to be improvement for all, but you really cannot wonder that a young man, if he happens to be daily associated with a lot of halfway machinists whose sole idea is to give as little for their wages as will be accepted, gets to thinking the same way that they do.

When we see young fellows, strong, quick-witted and capable, deliberately turning their backs on opportunities, it rouses our disgust with humanity; but if we stop to think of it, possibly it is best that things are as they are. Suppose that tomorrow morning every man in the country should suddenly be aroused to do his utmost, to work hard and long. The amount of work piled up at night would be astonishing. In a few days overproduction would be marked. These workmen would be too busy to stop and buy things. Overproduction always results in a drop of prices. Drop in prices results in drop in wages, drop in wages means less consumption, and so on around and around until the business world has taken its emetic and settled down. In this case it would undoubtedly settle down to long hours and very small pay for a great quantity of work. As it is today, only a few really work hard, and intelligently; only a few work long hours, and consequently only a few are getting more than their share of the good things. The rest of us have paid, and will pay, tribute to them and their heirs in increasing ratio, just so long as we are content to let them think for us and just so long as we are content to play the game of follow my leader. When we "common people" get to the point where we will think for ourselves and act as we think, without regard to the neighbor across the road, then there is some hope that we may have the comforts of life with also the leisure to enjoy those comforts. But I believe that we may trust in an all-wise Providence to guide us so that the ambition to work, really work with brains and hands at once, may not come to us all at once till we have lost that greed and selfishness which today leads men on to become multi-millionaires.

To prove that other incentives than Mr. Plaisted's articles have a livening effect on my thinking apparatus, I would like to pass along to your readers a question which was put to me not many days ago, as to whether it was policy to start a machine shop with some second-hand tools, or, if new tools were to be bought, of what grade they should be. The man who asked the question knows a good deal more about it than I do, but it set me thinking.

I have run a machine shop with about every conceivable kind of tool from second-hand stuff advertised as "fair," up to Pratt & Whitney and Brown & Sharpe tools. In order to be perfectly frank I will say that I have and will present a rather definite idea of the question, but that I am open to a change of opinion, and may be just as likely as not to write on the other side of the question by another month.

When a man buys machinery, he usually does it so that he may expect to make money. In order to make money, his machinery must turn out work of a certain quality and quantity. Some machinery has an output which is almost independent of the operator as to both these items. Machine tools, such as go into a simon pure machine shop, depend more on the operator than on the tools themselves for their efficiency. Take a planer: If the table travels in a straight line, if the cross rail is straight, and if the heads travel in straight lines, then the

planer can be adjusted to do perfect work. No planer is so far gone that it cannot be repaired to do well nigh perfect work. But it may do perfect work if coaxed; and yet if a decent cut is put on it may refuse to stir, or the head and cross rail may give and the tool dig in, or the table may spring all out of shape if the work is strapped down hard enough to hold it. These things usually cannot be remedied without so far rebuilding the tool that it costs more than a new one.

Here again we can always conceive of a lot of work about a shop which is so light in itself that it would spring or bend under cuts even as heavy as our old decrepit friend can carry. And if we are planning our work it is often possible to allow so little finish on castings or to have our forgings made so near to size that they may be finished on a light-powered machine. The question as to whether rough stock shall be brought close to size before being machined, or whether it shall be brought to the machine in a little cheaper form, and then have the stock hogged off depends largely on the equipment of the shop, and *vice versa*, the equipment may be made to depend largely on the owner's frame of mind toward this question. It is more easy to justify the use of second-hand tools of some other types than planers. Take a lathe: Except for a few radical high-speed machines, it looks about the same as it did 40 years ago. I have before me some old photos of lathes built by Wood & Light, and by the New York Steam Engine Company, about 1870-5. They have pretty fair power, and in many ways are almost, if not quite, equal to some machines advertised in your columns today. Take an upright drill: Except for some work where the high-speed drills can be forced, the old ones, if refitted to be accurate, are as good as the new, with the exception of automatic stops, most of which are worth more as talking points to sell the machine than as useful attachments a year later. And even on high-speed drills there is a question. I have just had a chance to see some tests where a drill, half inch or three-quarters, was pushed through cast iron at about 12 inches per minute. I used to sit in front of a drill press quite a little before this new steel came in, and if I got through a hole an inch deep in a minute I thought I was doing pretty well. But the joke of it is that if one of these drills strikes a blow hole it is used up. You cannot stop the machine quick enough to save the drill. And high-speed drills run into money so fast that an occasional breakage costs more than they save in the meantime on the work done. The designer of this drill is scheming now on some sort of a device to make the drill smell out a blow hole ahead and stop before it gets to it.

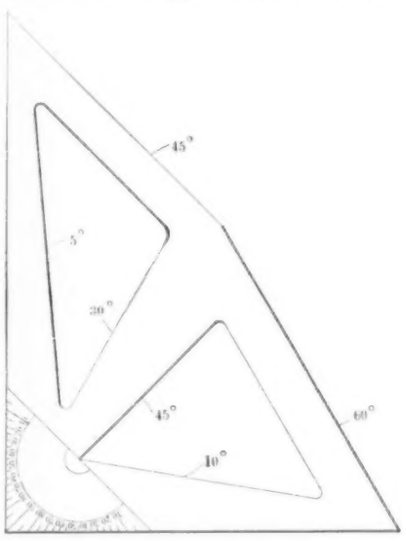
As for the different qualities of new tools and their relations to prices: If you can find a low-price tool of good design, which is a trifle unlikely, and then refit it on honor where it needs it, you are just as well off as if you bought a medium-price tool of the same design unless the refitting has cost more than the difference in price. That is, you will probably pay about the same price for a tool of given capacity before you have it where you want it, provided you don't go to the limited number of high-toned manufacturers who will charge you double, or more, what anyone else will and sell you mechanical perfection or close to it, which mechanical perfection your average shop hand will put out of commission in about three days.

ENTROPY.

A Combination Triangle

The inclosed sketch shows a combination triangle which I have used for some time, and with the protractor added as per Mr. Bowen's article at page 248, it is still more useful.

With the ordinary triangle one is constantly turning it over to get opposite angles, but with the one shown it is unnecessary, as one can get the opposite angle to both the 60 and the 45 degree edges from the angles in the center. It also has a few more useful angles added, which are very often required, such as 5, 10, 15 degrees, etc.



A COMBINATION TRIANGLE.

ARTEBE.

A Geometrical Puzzle

Referring to "A Geometrical Problem" by E. H. Lockwood at page 189, and different solutions for same, including one by myself at page 414, I wish to point out a very obvious error in my solution, namely, the statement that "the problem is impossible unless points A and B are equidistant from lines RP and QP respectively." I expect to get rapped over the knuckles for this by somebody, and, in fact, consider my solution very inadequate as compared with others offered.

WILLIAM WHALEY.

Information Wanted about Journal Bearings

Like the poor, journal bearings are something we have always with us, and considering the amount which has been written about them, it is certainly disappointing to find how little of it is applicable in specific cases. Outside the one field of steam-engine and locomotive journals and crank pins, I have been able to find almost nothing of authority except "glittering generalities."

In the field of wood-working machinery there must have been developed many interesting cases of peculiar behavior of journal bearings, but does anyone know of their ever having been reduced to a scientific basis, or even recorded? These journals run at extremely high speeds, and all the conditions under which they work are about as variable as they well could be. Where could you find a more promising field for useful and interesting research? Some makes of machines are heavy and massive, others light and springy; some stand on rigid foundations, others are little better than suspended in the air; some bearings get copious lubrication with considerable regularity, others get very little, and at any old time that is handy; some are well cared for generally, others shamefully neglected; some are driven by narrow belts much overworked and overstrained, others by wide belts with a moderate degree of tension; some are lengthy and of small diameter, others short and of such diameter that the rubbing speeds are excessive. What more do you want for variety?

And if all this were not enough, there are those subject to end thrust, from the rapidly reversing drum shafts of the sanding machines to the continued pressure on molding and machine spindles, which are upright and often fitted with bearings more or less conical in shape.

Planer cylinders furnish still another class, for added to their great speeds are hammer-like blows which they have to withstand from knives in a deep cut. On the whole it seems as if there was here lying fallow a field broad and wide enough to keep quite a number of observers busy for some time to come, and this article is written almost entirely in the hope that it may draw out from somebody the information which I have never been able to find in print on these matters, and which should be set forth for the benefit of designers with as much conciseness and authority as has been brought to bear on the engine journal.

Of course some rather interesting cases have fallen under my own observation, for our machines go into all sorts of places, and work under all sorts of conditions; but it would take someone with scientific training and a thorough knowledge of higher mathematics to dig down to the underlying principles which must have gov-

erned all these seemingly contradictory and unnatural manifestations.

Then, too, unless the case is at home, or close by, it is impossible to tell just how much the "personal equation" has to do with it. When we get reports that a certain bearing on a certain machine is running hot, and that nothing the operators can do seems to help it much we might not blame them for thinking the fault was one of design or construction; but if, as often happens, we know an exact duplicate of that machine is running in the same section of the same State, on the same class of work, but doing more of it and giving perfect satisfaction, then we are inclined to think the trouble is in the men and not in the machine.

Sometimes there is a vast deal depending on the safe and proper working of a journal bearing, not only valuable property but human life as well. In the case of a large circular saw running at a rim speed of ten thousand feet per minute, the force stored up is tremendous, and it is sometimes necessary that this be held down and controlled by a single bolt, in order that the same may be "lined" conveniently. It is better that this bolt should not let go; we may not have a chance to try a second one of larger size, at least not in this incarnation.

This was brought home to me a good many years ago, in those old days when I was getting my "grounding" at the machinist trade. I was filing a long and heavy arbor in the speed lathe, and from that day to this I have not ceased to wonder that the comparatively tiny conical center can hold these things in place as it does. This was not the first one I had filed and polished, but all the others had given warning squeaks and squeals when the center began to get dry. For some reason this one never emitted a sound, and the first indication of trouble I had was when it began to oscillate under my file. I shut off the power before the center was quite burned off; but just suppose I had been a bit too late, and that arbor had spent its stored energy sailing through the shop.

I believe that machine builders and machine designers might do a great deal to benefit themselves by the mere process of recording and comparing the results shown by various bearings under various conditions.

When I first went into photography I "snapped" at this and that, and once in a while made a time exposure, but never kept a record of results, or thought of doing so. If the negative proved good I blessed my luck; if it was a bad one, I tried again. But in spite of accumulating experience, I did not seem to progress much, as long as I went on in this way. After making several hundred negatives I was no more sure of results than at the beginning. Then I began to keep a record of the length of exposure, size of stop, time of day, season of the year, and general lighting conditions. These records have not only proved most useful for reference, but the mere making and comparing of them have greatly benefited my judgment as to what sort of exposure is best adapted to a given scene under certain conditions. In other words, I am more sure that when I take a picture the negative is going to be what I want it to be. And as not all views can be tried over in case of failure the better the judgment is trained in this respect the more satisfaction and success is attained. But no matter how carefully one keeps records like these the judgment will never become absolute and infallible. While to the eye the conditions may seem to duplicate those under which certain results were attained, there may be present some peculiar tint in the sky to which the plate is acutely sensitive, but which has no effect on the retina.

We cannot expect infallibility of any rules and formulas that may some time be published for the proper design of bearings in wood-working machinery, but we surely have a right to expect more definite and conclusive information than has heretofore appeared, so long as the chances for observation and experiment are so numerous and so widely distributed. With all the help we are ever likely to get in this way we shall still have to try and try over again before we arrive at correct proportions in some cases, but, as in the case of the photographs, the nearer we get our first guess to the right one the better we shall feel about it. As my old boss used to say, "It's all right to guess at if you only guess right."

E. R. Plaisted.

Tempering Novo Steel with Cyanide

The article on this subject at page 216, by Carroll Ashley, interested me considerably, as I have had somewhat similar experience. In hardening small dies or cutters in oil, I generally put cyanide on.

And now comes Common Sense at page 352, and advises Mr. Ashley to "forget that such a thing as cyanide is in existence," and that the steady and indiscriminate use of cyanide is a bad habit to get into, etc. Common Sense shows the prevailing prejudice of the majority of tool makers against cyanide.

To show that this prejudice is groundless, note the fact that one of the largest manufacturers of small tools in the country, who has a world-wide reputation for good work, uses cyanide on practically every article that is hardened, excepting Novo steel, regarding which Common Sense is right.

Cyanide used on tool steel can do no harm, provided always that the article to be hardened has the right heat. Cyanide only cleans the surface as the water or oil gets to it, quickly and evenly. If a piece is heated too low, the use of cyanide will very likely cause a surface hardening or case-hardening, which probably accounts for the prejudice of many toolmakers.

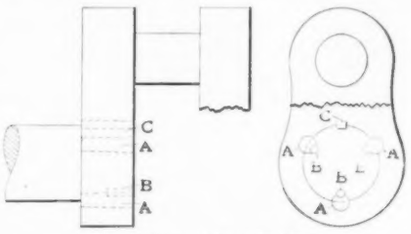
J. F. B.

Bottom-end Bolts — A Crank-shaft Repair

At page 57, Vol. 28, Part 1, an article was published in which the use of the short spanner and heavy hammer for tightening up nuts on bottom-end bolts of marine engines was condemned.

As a practical machinist and engineer, with 35 years' experience on locomotive, marine and stationary engines in large shops with modern tools, in small shops with some tools, in the backwoods with a claw hammer and a broken file, I think that I am in a position to express an opinion on the subject.

I have tightened up 5-inch bolts in bottom ends and main bearings on board ship and would hate to undertake the job with a wrench long enough to do the work properly, as I am afraid that one end of the wrench would be in the stokehold or



A CRANK-SHAFT REPAIR.

out on the wharf. I have seen hundreds of ⅞- and 1-inch follower bolts in locomotive pistons strained or broken by the injudicious use of a socket wrench and tommy bar, but have yet to hear of a similar occurrence on large bolts set up with a short wrench and hammer. It all hinges on the man who does the job.

This brings to my recollection a repair job that was done on a marine crank shaft, that might interest your readers.

The 10-inch crank shaft of a fore-and-aft compound engine was reported as having the after l. p. crank web loose on shaft. As it would have cost considerable money and time to remove the shaft and repair it, the following plan was adopted. To the best of my knowledge the shaft is still in service and has given no more trouble.

Three 1½-inch holes were drilled, as shown at *A*, and reamed with a taper reamer, ⅛ inch to the foot taper. Tool-steel plugs were then turned to the same taper as the reamer and small enough to enter in the holes about 2 inches. The plugs were then eased off on two opposite sides and forced into the holes with jack-screws and wedges.

The final operation was to drill and tap three ½-inch holes 3 inches deep, half in each plug and half in the shaft, into which screwed plugs were fitted and cut off flush.

Senex Occidentalis.

Vancouver, B. C.

Flutes in Worm-wheel Hobs

I wish to ask for some information in regard to the number of flutes in relieved hobs with multiple threads.

In my note book I have the following memorandum copied from the AMERICAN MACHINIST, June 29, 1899, page 593, where Oscar J. Beale states: "The spacing of a hob must be equal to the circumferential distance occupied by either one or to any whole number of threads." I do not quite understand the meaning of this statement, and everyone in our drawing room seems to have a different understanding of it; and I would be pleased if somebody would make this statement somewhat clearer.

There was one case that came to my notice, where a septuple-threaded hob was made with 6 flutes to hob a worm wheel with 77 teeth, the hobbing to be done on a special attachment. According to my understanding of the above statement, this hob should have worked satisfactorily, but it was a failure.

Another time an octuple-threaded hob was required to hob a 98-tooth worm wheel for a cream separator. This was made with 8 flutes, and also failed. Another one was made, but with only 7 flutes, and this one was satisfactory.

The other day there was a drawing sent to the shop for a triple-threaded hob for hobbing a 24-tooth worm wheel; the drawing called for 10 flutes, but the superintendent returned it with the remark that a 10-fluted hob would not work; there should be 12 flutes. He also mentioned that if there was a "hunting tooth" in the worm wheel—in other words, if the number of teeth was not a multiple of the number of threads in the worm, say 23 teeth—then a hob with 10 or any other number of flutes would be satisfactory.

Is there a simple formula, and what are the elements to be considered in determining the number of flutes?

This information would not only be interesting to me, but to quite a number of your readers. H. I. C.

We sent this inquiry to Mr. Beale, who replies as follows:

H. I C., in his letter in regard to the number of flutes in multiple-threaded hobs to cut the teeth of worm wheels, states that he does not understand my statement that "The spacing of a hob must not be equal to the circumferential distance occupied by either one or to any whole number of threads."

The difficulty in understanding this statement comes from using the word "spacing" in the sense of "space," or "the width of space," between two consecutive flutes. I now think this use of "spacing" is not quite correct, or certainly quite unusual. The correct term is "the circular pitch of the flutes."

It might be well to recast the statement thus: "The number of flutes in a hob must not be equal to the number of threads; the number of flutes must not be either a multiple or a submultiple, or factor, of the number of threads." It is also well not to have the number of flutes and the number of threads contain a common divisor. Or, in fewer words, "The number of flutes should be prime to the number of threads."

We might call this differential spacing. The object of the differential spacing is to have every tooth in a hob cut the worm wheel in a different relation from every other tooth, in order to avoid ridges too pronounced on the sides of the worm-wheel teeth. There might be another trouble: I had a hob in which the circular pitch of the flutes was equal to the circumferential distance between two threads, or there were half as many flutes as there were threads; the action of this hob was the same, practically, as if it had only one thread and one flute, and perhaps worse. The worm-wheel teeth jammed against the heels of the hob teeth, and the big, powerfully driven hobbing machine would not go.

Examples: An eight-threaded hob must not have eight equally spaced flutes, because, so far as the smoothness of the teeth of the worm wheel is concerned, the hob would cut as if it were single-threaded with only one flute; seven flutes would cut smoother. An eight-threaded hob should have something different from four flutes because four is a factor of eight, and the hob would cut as rough as if it had two threads and only one flute.

In the case of the number of flutes being a multiple of the number of threads, the worm-wheel teeth may be smooth enough if the number of flutes is four or more times the number of threads; my statement applies to ordinary cases that come up in every-day practice. I have just come from a hobbing machine in which a triple-threaded hob with twelve flutes is cutting a wheel of forty-five teeth; as the number of flutes is four times the number of threads, the hob cuts as if it were single-threaded and had four flutes. The worm-wheel teeth are passable, but they would have been much smoother, if the hob had thirteen or even eleven flutes. The hob is half-inch linear pitch, and 1½-inch lead.

This brings us to another point; if the triple-threaded, twelve-fluted hob were three inches linear pitch or coarser, the worm-wheel teeth might be regarded as altogether too rough.

In the case of a triple-threaded hob, cited by H. I. C., the ten flutes called for on the drawing will cut much smoother teeth than twelve flutes, no matter what is the number of teeth in the wheel.

If an eight-threaded hob has sixteen flutes, it will cut about the same quality of teeth as if it were single-threaded and had only two flutes, and if it were one inch or more linear pitch, the teeth cut by it might be regarded as too rough.

The smoothness of the teeth is affected by the diameter of the worm wheel; for example, the same hob will cut smoother in a wheel of a hundred teeth than in one of twelve, because in the former case the tooth sides are not so much curved, or have a longer radius of curvature.

Another point learned in the works of Messrs. Brown and Sharpe is that a hob will sometimes cut rough teeth if the number of teeth in the wheel is a multiple of the number of threads in the hob, even though the hob is fluted in accordance with what I have pointed out in this letter. Thus, a triple-threaded hob cut rough teeth in a fifteen-toothed wheel, also a quadruple-threaded hob in a sixteen-toothed wheel.

H. I. C. cites a case in which a seventy-seven toothed wheel is a multiple of a seven-threaded hob having six flutes. The trouble in these cases is that every space, between two teeth in the wheel, is cut by the cutting edges in only one thread of the hob, and these cutting edges may be so few as to leave ridges.

We must have flutes enough, no matter what the other conditions are, but I should expect a single-threaded hob with six flutes to cut smoother than a seven-threaded hob with six flutes, because the single-thread has to make more turns to one turn of the worm wheel.

Providence, R. I. OSCAR J. BEALE.

A Steam Trap

This is the description of a steam trap which worked with absolute reliability until it was put out of business by a dissolute mechanic with malice aforethought and a little suitable material.

Two of the ships of the fleet belonging to a line of passenger steamers trading into New York have a ventilating system whereby the foul air is drawn from the various rooms by an exhaust fan. The conduits are of sheet iron, rectangular in section. In order to save head room they are about seven inches wide by three inches deep and hung from the ceilings. They are equipped with small sliding doors so that each individual can regulate the amount of ventilation he desires.

The exhaust fans are situated up on gratings above the engine tops, and the engines that drive them eat up an awful lot of steam.

In all the years that I have been connected with ships I have never once heard an engineer complain of getting too much steam; these two ships are no exception to this rule. There is at sea a constant rivalry between watches to get the most revolutions, as revolutions mean steam, the watch with the highest average pressure, other things such as sea and wind being equal, comes out ahead.

At a time when fires are being cleaned it's remarkable what a lot of steam a couple of fan engines can get away with, so it's little to be wondered that at fire-

cleaning time the engineers would slow down the fan engines. This sort of thing went on with an occasional kick from the bedroom steward, to which no one paid any heed, till at last it became recognized as custom and custom at sea is a hard thing to change.

At length the old chief was transferred, and Mr. Walsh was assigned to the S.S. "Old Country." The first night at fire-cleaning time the junior engineer (according to custom) slowed down the fan engines; the next moment the chief shouted down the speaking tube, "What's the matter with the starboard fan engine?"

"Nothing, Sir."

"Then give her a little more steam."

The same thing occurred on the next watch.

In the mess room the thing was discussed in all its phases, each man telling his yarn and adding a little to it each time he repeated it.

Was the chief suffering from insomnia?"

In Park Row there is a "Beanery" which never closes. When the place was started years ago the owner threw the key away. Over the door runs the legend, "Dolan never sleeps." Was our chief *Dolan* in disguise? So we engineers put our heads together and agreed to slow down the fan engines alternately every half hour and note carefully the results. In this way we found that the port fan engine had no effect on him, but the moment the starboard engine was slowed down the chief would blow the speaking-tube whistle. It did not make any difference when the engine was slowed down, day or night, if the chief was *in his room* the result was the same. The moment the valve was closed the whistle would blow, and the chief would state his opinion of the engineer on watch.

This mystery went on unsolved for several voyages. One night I was in the barber shop about 10 o'clock, chinning to the barber. A hinged panel in the bulkhead between the chief's room and the barber shop, was open.

A sound like sawing hickory knots issued through the opening. Stepping quietly over, I pushed the curtain aside and peeped into the chief's room; there he was, lying on the broad of his back, with the light turned low, snoring like a grampus. The sleepless one was asleep. I turned out the electric light in the barber shop, and after telling the barber what I intended to do, ran down to the engine room, where I told the engineer on watch what I had seen. It was quickly arranged that in exactly five minutes he would shut down the starboard fan engine, and back I ran to the barber shop to solve the mystery. Standing in the darkened barber shop, peeping through the opening between the curtain and the bulkhead, I waited with strained ears trying to single out the noise of the starboard fan engine from the confusion of sounds arising from the main and auxiliary engines below.

Suddenly a rectangular mass dropped from the ceiling above the chief's bunk, and hit him in the pit of the stomach. In an instant he was wide awake, reached for the speaking tube with one hand and switched the light full on with the other. The rectangular mass was now easily distinguished as an empty cigar box with the lid nailed tight. When the engineer below gave the starboard fan engine full steam, the chief placed it over the opening in the air duct just above his stomach, where the suction in the conduit held it in place.

Next day, when the chief was on deck, I slipped quietly into his room and glued the cigar box in place on the conduit. The trick went undiscovered till the fan engine was shut down for repairs in New York.

DIXIE.

Precision Cams for Watch Making

In watch manufacture it is necessary to have cams of greater accuracy than those produced by ordinary methods and to accomplish this the following plan was adopted by the South Bend Watch Company, by which cams are made to work to 0.0001 of an inch with very little trouble.

Following is a description of the method of laying out and cutting the cams and, with the aid of the accompanying sketches, it is hoped the reader will get a clear idea of the scheme:

First a chart of all the motions required by a machine is laid out as illustrated in Fig. 1, the motions being laid out from a transverse line called the position line. This line is used for placing all the cams in the right position in the machine at once, and for keeping them in proper relation to each other on the chart. By the aid of the chart one is enabled to determine just what one cam is doing in relation to another, as well as to plot the motions.

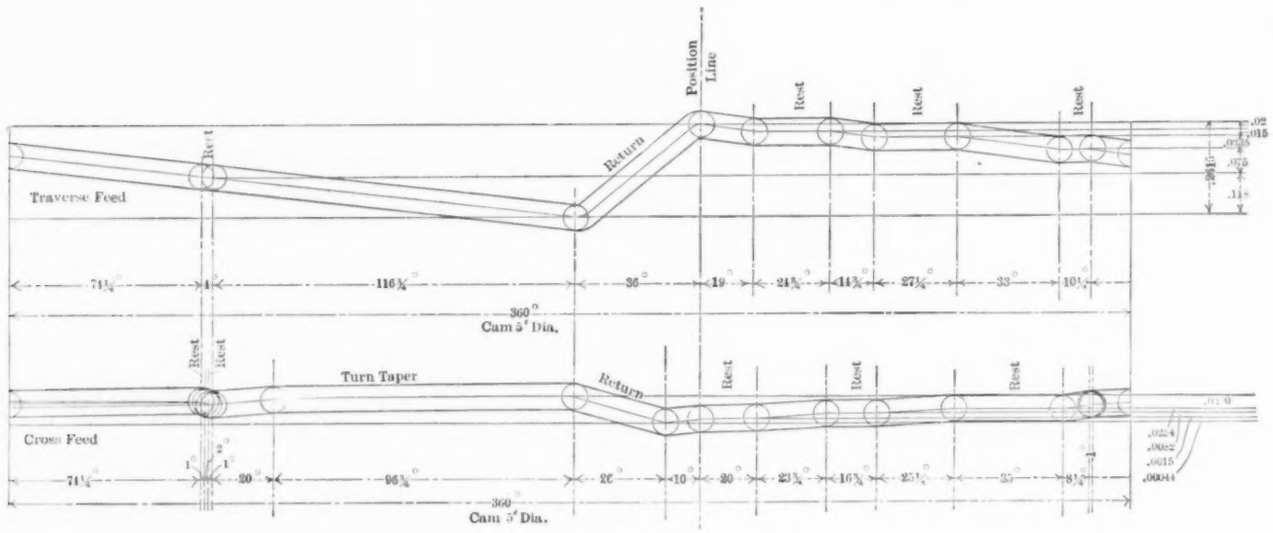


FIG. 1. CAM CHART FOR TRAVERSE AND CROSS-FEED CAMS FOR TURNING STAFF SHOWN IN FIG. 5.

The cams referred to are 5 inches in diameter, the length of the chart being equal to their circumference and to 360 degrees, from which it follows that 1 degree equals 0.0436 inch on the chart. The degrees for each rise, rest, etc., are determined by the ratio of the travel in inches on the work to the circumference of the cam.

In Fig. 2 the travels, rises, rests and returns are represented by dotted lines which show the movements of the tool operated by the cams, which are cut from formers as shown in Figs. 3 and 4 to turn the staff shown in Fig. 5.

The cross-feed cam feeds the tool in or out, facing the little shoulders and feeding for the right tapers, etc., while the traverse cam feeds the tool lengthwise of

the staff, both cams working in unison.

From the cam chart the formers for the cam-cutting machines are made or laid out. They are made of brass ⅛ inch thick, the rises or throws being 5 times greater than the cam and as the cam is 5 to 1 over the work, the former has a total ratio of 25 to 1. This high ratio is used to reduce the errors in workmanship and to produce cams of great accuracy.

In laying out the formers, starting from the position line as shown in Figs. 3 and 4, the lines are scribed on the face with fine pointed dividers and beams and are made quite deep. The former is then sawed out nearly to the line by milling.

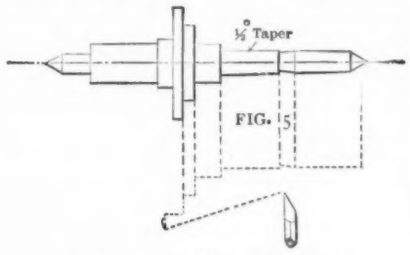


FIG. 2. THE WORK OF THE CAMS

The center for each radius of a rise is fitted with a pin which is used to swing the former while milling. The hole in the center of the former fits the cam-cutting machine, being used to center it.

The principle of the cam-cutting machine is very simple, but it does very accurate work, the cam blank being held by a headstock which is fastened to a slide and the former is screwed to a turntable. As the head and turntable are geared together they turn as one. The head that holds the mill is stationary and is fed in and out only for depth of cut.

A large lever having a ratio of 5 to 1 is connected to the cam head and a roller at the other end of the lever follows the former, thus reducing the rises, etc., 5 times. The cams shown are only two of many hundreds and by the use of the formers cams may be duplicated or changed at any time. In changing a portion of the work we simply saw out the part of the former that is to be changed, solder in another piece and finish as before.

ARTEBE.

Roll Grinding

Referring to the contributions on this subject at page 712, Part 1, and page 187, both Mr. Noyes and Mr. Hollinger seem to misunderstand me. I was not expressing an opinion, or advocating any theory. I was simply stating a fact that I had observed that large centers on a modern grinding machine actually do away with the necessity for, or advantage of, bearings for grinding a roll on its neck; that, when the centers are properly made for grinding the journals accurately round, the roll body can also be ground round on these centers without any bearing for the neck.

I cannot see that Mr. Noyes' reference to a long table, or the position of the roll on the table, or the position of the table as regards overhanging on the bed of a grinding machine has anything whatever to do with the question whether a roll should be ground on its centers or on its journals. He is simply supposing that some time he will have a machine unsuitable to grind the roll. That is not the point. I was not discussing grinding machines. Such a grinding machine as he describes should not be used for a heavy roll. If it is, he must take the consequences; but that does not, as I see, have anything to do with the matter of grinding rolls on centers as a principle. If both Mr. Noyes and Mr. Hollinger will read my first article, they will see that I was not discussing a question, I was simply stating a fact.

For the benefit of those who may not have read the other article, I will say that it is a fact that accurate roll bodies are ground today, when the roll is rotating on centers only, and that they are ground very quickly. Of such rolls 1800 were ground in one works in 360 hours. This, of course, included the putting in of the rolls in the machine and taking them out. They were accurate rolls. They did not have journal bearings or supports.

C. H. NORTON.

Send Your full Name and Address

Again we must remind our friends that it is no use to send to this office inquiries, requests for advice, for information, or anything whatever unless the communication is signed with the full name and address of the sender. We can pay no attention whatever to communications which are anonymous, or which are signed by initials only.

The Ilion *Citizen* issues a special number dated October 4, in which many of Ilion's industries are illustrated and described. Needless to say this paper has a good deal of good material to work upon, the Remington Arms Company and the Typewriter works being in themselves sufficient for a good deal of interesting matter.

A crank has been defined as a specialist in something in which you are not interested.

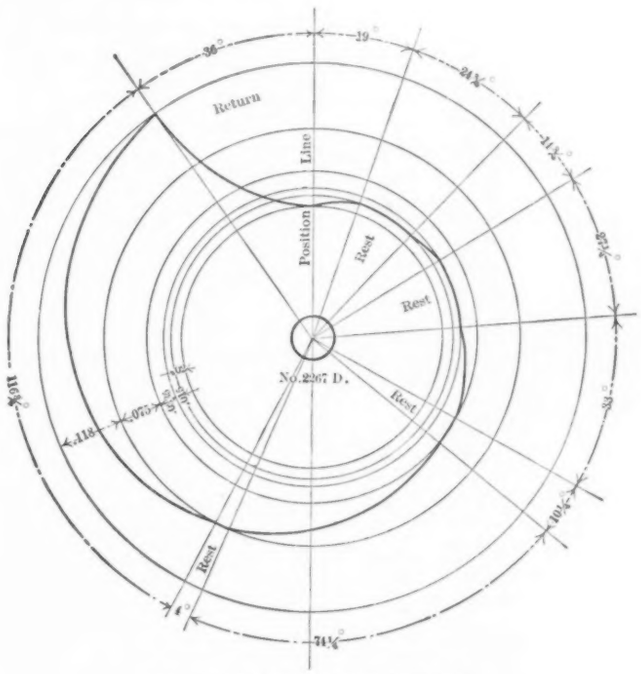


FIG. 3. FORMER FOR TRAVERSE CAM

FIG. 4. FORMER FOR CROSS-FEED CAM

AMERICAN MACHINIST

Issued Weekly by the

Hill Publishing Company

505 Pearl Street, New York.

Also Published at 6 Bouverie Street, London, E. C.

Correspondence on mechanical subjects solicited and paid for. Name and address must always be given—not necessarily for publication.

Address all business communications to the American Machinist, 505 Pearl Street, New York. Matter for reading columns may be addressed to the Editor.

Subscribers can have address changed at will. Give old and new addresses. Date on wrapper denotes end of month in which subscription expires.

Subscription price $4 per year, postage prepaid, to any post office in North America; $5 in all foreign countries except Europe and British possessions in Eastern Hemisphere.

The AMERICAN MACHINIST CO., LTD., 6 Bouverie St., London, E. C., will serve all subscriptions for Europe and British possessions in Eastern Hemisphere. Price 30 Shillings for England. For all other countries in Eastern Hemisphere, 35 Shillings.

No back numbers beyond current year. For sale by all newsdealers generally.

Entered at New York Post Office as mail matter of the second class.

Cable Address, "MACHINIST," N. Y.
Lieber's and A B C Codes.

During 1905 the AMERICAN MACHINIST printed and circulated 1,059,100 copies, an average of 20,367 per issue. Of this issue 17,750 copies are printed. None sent regularly free. None taken back from newsstands. No back numbers beyond current year.

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Choice of Men and Choice of Shops

Although we don't hear so much about it, nor see so much of it in print, the present situation in machinery-building establishments is somewhat analogous to that which is set forth by the paragrapher who represents the prospective employer as saying to the prospective cook, "Why did you leave your last place?" and receiving the reply, "Well, now, why did your last cook lave hers?" The answer to that question would in many cases be embarrassing, and although machinists and others who are in such strong demand at present are not in the habit of interrogating prospective employers in such a way, they nevertheless do have ways of finding out why previously employed men have left. They generally have a pretty accurate idea of whether a shop is a good one to work in or otherwise, and it is correspondingly easy or difficult for such shops to employ good men; making, of course, all due allowance for the fact that in these times very few shops, even the best of them, find it really easy to get good men; there are not enough of them to go around.

These are times in which men are able to choose, and when not only wages, but sanitary appliances, light, location, decent treatment by foremen, superintendents, etc., steadiness of employment, or likelihood of such steadiness, and many things not ordinarily looked into very closely are now considered and have weight in determining in a given case whether a good man will apply for employment or not.

The proprietor of a machine shop sends us an account of an incident which took place recently in another shop which has been losing a good many men recently, and which incident has a bearing upon this question. A foreman, excited and with much profane abuse, shouted to a workman, "What ——— are you doing there? It is such ——— men as you that spoil a shop." As it happened the man was not in the least at fault, but that is unimportant.

The proprietor who sends us the account remarks that "it is not the man abused who is spoiling the shop, but the foreman who abuses him." His behavior goes much farther than merely to discourage and disgust the man he talks to—not only will this man leave at the first opportunity, if he is worth his salt—but the treatment he has received will be known among good men generally in the neighborhood, none of whom will, if he can avoid it, place himself in a position to be abused in a similar manner.

Nothing can be more certain than that the foreman who drives and abuses will sooner or later have in his employ only those men who must be driven and abused, or who are at least indifferent to it, while the foreman who leads and helps and suggests, so as to bring out in men the best that is in them, and enlists their active and voluntary co-operation, will soon have men amenable to such treatment; in other words, the best men that are to be had.

It is quite customary for shops to rather carefully look into the qualifications of men whom they may be considering, especially when men are plentiful. It would save a good deal of trouble and bother if the men also were more careful than they usually are in looking into the conditions of employment in establishments where they propose to go to work. In these times they can afford to do that, and undoubtedly are doing it much more than they do in times when jobs are not so plentiful.

Shall the Wives of Workingmen Go into Factories and Shops?

A thing to contrast with the song of praise we are continually hearing about the great benefits conferred upon humanity by labor-saving machinery is the suggestion recently made in *The Independent* by Dr. Simon N. Patten, who is professor of political economy in the University of Pennsylvania and a recognized authority upon economics. In this article he expresses the opinion that wives whose husbands have an income of less than $20 a week ought to work in the factory, the shop, or the office, to help out with the family expenses. His principal reason for this appears to be that the introduction of labor-saving machinery now used in factories has largely done away with much of the labor which was formerly performed by housewives within their own homes, and yet the necessity for their laboring exists. As Dr. Patten may readily ascertain, comparatively few of the workingmen of this country earn as much as $20 a week. If, therefore, his advice is sound, the wives of a large majority of such workmen should perform some work outside their own homes in an effort to help support the family. This, of course, would inevitably mean the neglect of the home-making duties, and the practical breaking up of many humble homes.

If the results of all our boasted advances in the sciences and arts and in the construction and use of labor-saving machinery are no better than this; if after all that has been done in that line, wives of men who earn far more than the average recompense of labor in this country, must leave their homes for outside employment, and we must accept that as a necessary condition, then all our arts and sciences are of little or no real use.

Dr. Patten would, in our opinion, do much better if he devoted his talent to a study of distribution and to an answer to the question of why it is that colossal fortunes are being amassed by means of monopolies and special privileges of various kinds—money accumulated by men

to such an extent that they are utterly unable to make proper use of it, while at the same time the problem of support for workingmen has become so insistent and obtrusive as to make it seem to him necessary to propose such a remedy.

And supposing workingmen and their wives generally accepted this suggestion, what effect does Dr. Patten think that would have upon wages and upon the constant tendency to force young children into factories?

Socialists who believe that the use of privately owned labor-saving machinery is one of the chief causes of our economic and social evils and who seek to "nationalize all means of production" will welcome Dr. Patten's suggestion as an authoritative confession of the failure of the present system. We by no means make any such acknowledgment. We do not believe that machinery oppresses men. Monopolies do that. Unfair advantages; special privilege; failure to secure a "square deal" for every man; these are the things that hurt and when they are done away with we shall then have heard the last of the "crushing effect of machinery" and of the necessity for women with able-bodied husbands going out of their homes to work for daily bread. With all due respect to Dr. Patten, his suggestion is discreditable to the science of political economy as taught in our colleges.

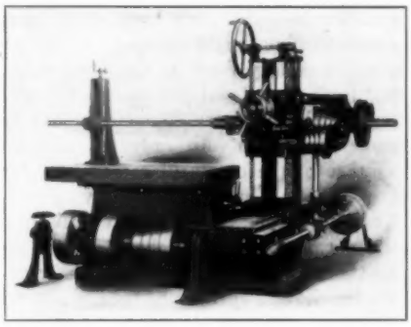
The seventh year of the School of Commerce, Accounts and Finance of the New York University was opened on the evening of September 27, 1906, at the University Building, Washington Square East, New York City, the principal feature of the exercises being an address by Hon. James Rudolph Garfield, United States Commissioner of Corporations, in which Mr. Garfield spoke of the unscrupulous methods followed by many business men today and the abuses in the management of corporations, unfair competition, etc., and advocated as remedies the education of the business man and the instilling of correct ideals and principles, and publicity in the affairs of corporations. The New York University, in addition to its regular courses, carries on evening courses, so that its advantages are open to those employed during the day. Among the special courses are accountancy, finance, fire insurance, business management, real estate, actuarial science and railroad management.

Railroad Men states that the Illinois Central has been experimenting with sand gravel taken from the bed of the Mississippi, and is now considering the adoption of the product for ballasting its main lines. This gravel is the first really satisfactory ballast that the railroads of the West have found. Being thoroughly washed, it comes nearer to a dustless ballast than anything else that has been found.

NEW TOOLS AND MACHINE SHOP APPLIANCES

A HORIZONTAL DRILLING, BORING AND TAPPING MACHINE

This machine is intended for boring, drilling and tapping work that cannot be handled to advantage on a vertical machine. The table is 24x48 inches. The column has a travel of 36 inches on the



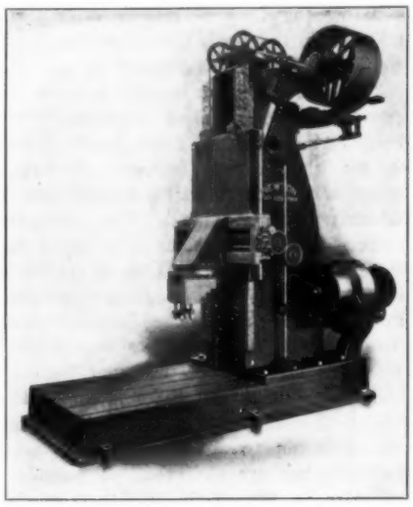
A HORIZONTAL DRILLING, BORING AND TAPPING MACHINE

ways. The head has a vertical adjustment of 18 inches. The total hight of the machine is 70 inches; floor space necessary, 90x102 inches; weight, 3800 pounds.

This machine is made by B. F. Barnes Company, Rockford, Ill.

SLOTTING MACHINE

The accompanying illustration shows one of the now well known portable slotting machines which are usually used in connection with a slotted floor plate, but



SLOTTING MACHINE

which is here shown mounted on a permanent base. It is intended for all classes of heavy butt slotting, although within its range it may be used for internal slotting. The ram is operated by a spiral pinion and rack with shifting belts and is fitted with its own motor, which is mounted on the back of the upright and connected to the lower pulley shaft by means of spiral gears.

The ram has a stroke of 48 inches, while the tool head has a cross feed on the ram of 30 inches and an in and out feed of 4 inches. The head has a relief block and swivels to make angular cuts as shown.

The machine is the product of the Newton Machine Tool Works of Philadelphia.

Detroit Meeting of the National Supply and Machinery Dealers' Association

As previously announced, the special meeting of this association was held at the Hotel Cadillac, Detroit, Michigan, September 26. President E. E. Strong occupied the chair, and 29 members were present. The public was not admitted to the sessions, which were entirely executive, but the following is an outline of the proceedings:

The Committee on Machinery made a report which related to the visit of the committee to the Atlantic City meeting of the National Machine Tool Builders' Association on which occasion the committee presented the claims of the National Supply and Machinery Dealers' Association for exclusive territory, protection therein, and an increase in the margin of profit allowed from 10 to 12½ per cent. The requests for exclusive territory and protection were both granted, although under conditions which partly nullified the purposes of the change. The request for increased percentage of profit was not granted, largely because of the subdivision of the Machine Tool Builders' Association into groups in accordance with lines of product.

Following the discussion on this report papers were read by Henry Prentiss on "The increased cost of selling machinery, and the interest of the manufacturer in a liberal policy toward the dealer;" by F. H. Brown on "Exclusive sales territory, and protection therein," and by C. A. Clark on "What can the manufacturer do to aid the dealer in distributing his product?"

The burden of Mr. Prentiss' paper was the increased cost of selling machine tools at the present time, as compared with a few years ago. He analyzed the items which go to make up sales expenses, and showed that nearly all of these had grown in recent years more rapidly than the volume of sales. In order to meet the present demand for quick deliveries, it is necessary for the dealer to carry larger stocks than formerly, and meanwhile the dealer has become more of a merchant than formerly—his stocks being now largely carried at his own expense, whereas formerly they were consigned for sale on commission. More serious still it is now necessary to employ salesmen to a degree formerly unknown. Formerly inquiries were answered, and sales largely made through the mail. At present it is necessary to send a salesman after each inquiry, and

this has involved an expense in salesmen's salaries, which was formerly unknown. The expense of handling goods, including cartage, has also grown, and there seems to be more damage in shipments than formerly. The expense due to the use of the telegraph and telephone also increases from year to year. The author of the paper believed that the manufacturers are ready to recognize these changed conditions, and to grant an increased percentage; but in the nature of the case they cannot be expected to take the initiative. The plan outlined in the report of the Atlantic City meeting of the Machine Tool Builders' Association he considered fair and reasonable, and thought it would settle the question if carried out in accordance with its spirit. The report was, in fact, all that could be expected, and showed that a readjustment was possible, which would be satisfactory to all parties.

Mr. Brown's paper enlarged upon the importance of the machinery merchant's business as essentially a part of the manufacturer's business. He considered that success in the machinery merchant's business was impossible without exclusive territory. He deplored the lack of uniformity among contracts between manufacurers and merchants, and suggested that a committee be appointed to draw up a satisfactory form contract for use between manufacturers and merchants, and outlined several provisions which he considered that such a form contract should contain.

Mr. Clark's paper discussed at considerable length the many ideas which are prevalent regarding means by which the manufacturer can aid the merchant, but he considered that superior to them all was the simple plan of making superior goods. To a very large extent a superior machine tool is its own advertisement and its own salesman.

General Increase in Manufacture of Machinery in Germany

Consul-General Richard Guenther, of Frankfort, in *Daily Consular and Trade Reports* states that the manufacture of machinery in Germany has increased at a rapid rate, especially during the last half of 1905. He says:

In the whole field of the machinery manufacture employment at fair wages was steady. The erection of new manufacturing establishments and the enlargement of existing ones, gave the machinery industry many orders. Both the automobile and rubber industry have increased rapidly and could not keep up with the demand. In the steam-engine branch competition by gas and electric motors was keenly felt, although employment was adequate and the prospects for the coming year are good. In transmitters the sales were large, although a number of foreign firms have permanent offices in the city, which cut into the sales of home manufactures to some extent. The manufacture of compressed-air tools and machinery has assumed great proportions, and the prospects for 1906 are such that large additions are planned to existing works.

The volume of business in the manufacture of milling machinery has increased considerably over the previous year. A trust of the large German establishments tries to regulate prices and terms. Employment in the factories of ventilators and centrifugal pumps has been good, many firms working night shifts. There are more than fifty firms in Germany manufacturing centrifugal pumps. In the sewing-machine industry competition has become very keen. In order to take advantage of the old tariff rates work during the second half of 1905 was very brisk. Trade in bicycles was good, especially in the cheap grades. In the electrical industry business was fairly satisfactory. Wages showed an upward tendency, being 10 to 15 per cent. higher than in 1904. Work in the industry of electric lighting, transmission of power, etc., was good, especially in the last half of 1905; so, too, in the manufacture of electrical measuring instruments and all electro-technical articles.

A special press cable from London announces the fact that at a fire which took place at Bray, England, a fire engine which was presented to the village in 1737 by Lady Coleraine was effectively used.

British and American Tool Builders — A Departure from Traditions

An item is going the rounds of the press taken from the *Daily Consular and Trade Reports*, which reads thus:

"How an American machinery agent secured an order in Japan is related by the commercial agent of New South Wales in the Far East as follows: It was a question of some lathes for a large factory which was being started. They were required of a certain size. The agent for the British firm said, 'That is 3 inches longer than they are made, and we can make no alteration.' The American said, 'I will make them to any size you like.' The American secured the order."

It seems to us that there is some likelihood that this story is a little mixed. It seems not to agree at all well with facts as they are observed. It is understood to be one of the traditions of the business that the British machine-tool builder will alter his machines to conform to the ideas of his customer; whereas with us it is the other way, and it is our builders who would be most likely to decline to make any change whatever to meet the views of a prospective buyer. Certainly if the incident did occur in Japan just as related, then all we can say is that it must have been an exceptional British firm and also an exceptional American firm, which in this case happened to be competing for the same order, for both of them did just the opposite of what they might be expected to do and what they must continue to do unless we are to radically change our ideas as to their respective reputations.

New Publications

"The Analysis and Softening of Boiler Feed-Water;" by Edmund Wehrenfennig, mechanical engineer, chief inspector of the Austrian Northwestern Railway in Vienna; in collaboration with Fritz Wehrenfennig, analytical chemist, director of factories in Eggenberg; translated by D. W. Patterson, M. E. Second edition, thoroughly revised. New York: John Wiley & Sons, 1906; 290 pages, 5½x9 inches. Price, $4.

This work places in a quite practical and convenient form much useful information on the subject indicated by the title. The means by which impurities get into water are explained. Definition is given of the German and French degrees of hardness and directions for analysis, the determination of hardness by the soap solution, and the ascertaining of alkalinity, the methods of examination being such as not to require an expert chemist for their execution. Drawings are given of a handy traveling case for parties making examinations of water in various places. Another portion of the book treats of the different methods of improvement of water, and the determination of the amounts of reagents for this purpose, in which, of course, the metric system is employed. It might be mentioned that in this part some very simple algebraic formulas are used in expressing the proportions. The book shows a considerable variety of apparatus for the purifying of water, and a very commendable system is employed in placing the reference letters and figures on the illustrations, so that in any of the drawings a certain mark always means a certain part; odd numbers being used for inlet pipes, even numbers for outlet pipes, small letters for receptacles, a capital *K* referring to lime apparatus, a capital *P* to raw water, etc. Examples are given of the studies regarding the installation of water-purifying plants for a water with given amounts of impurities. The book closes with a report on water softening by the Society of German Railway Managers, and a blank form for tabulating data about any particular water supply. On a large inset there is a table giving a very clear summarized statement of the various impurities met with in boiler waters, their effects and the means of counteracting them. There is a good index.

Including the present one, 1344 numbers of the AMERICAN MACHINIST have been published since it commenced in November, 1877.

Thermit Welding or Casting—Repairing Locomotive Frames by the Thermit Process—A Method Worth a Fair Trial*

BY GEORGE KELLY

It has been stated that thermit welding is not properly blacksmith's work, but is rather a foundry process. In many cases, however, general repair shops have no foundry, then the work naturally devolves upon the smith department. If any here are so situated, this paper may be of some profit to them.

It will not be necessary to give the general methods of procedure with thermit, as this information can be had in circular form from the manufacturers, and is more or less familiar to all master blacksmiths, but a few words are given pertaining to details of the making of the mold, drying and applying to frame.

The man who makes the mold should be thoroughly familiar with the instructions. The sand and clay should be thoroughly mixed stiff; experience having proved that the less the amount of moisture at the time of making the mold, the better the fit after drying. A mold made in the evening should remain at least from six to eight hours in a furnace at a low heat. Place one or two wires in the heavy part of the mold, so that they may be drawn out after drying, as a test that there is absolutely no moisture. After the paint and grease are removed, apply the mold at once, all joints being carefully luted with moist clay. To heat the frame to a red heat, apply an ordinary gasolene frame heater down the riser opening of the mold. The bottom of this opening can be made larger in proportion to the size of collar applied.

During the heating of the frame the crucible can be charged. After a couple of reactions the bottom of the crucible becomes enlarged and it is necessary to use more plugging material than the manufacturers apply in order to avoid premature tapping.

In addition to one charge of material we use the crushed light slag that comes from the previous heat, and this answers the same purpose as the refractory sand.

Have crucible, thermit, tapping material and punchings warm. Be ready, and as soon as the frame is red-hot, which can be seen by looking through the pouring gate of the mold, start the thermit and when the liquid steel has settled in the bottom of the crucible it is then tapped, allowing the steel to enter the mold at 5400 degrees of heat.

In preparing the break for the weld, the method we have found meet with the best results is to drill ¾-inch holes through the break, following the line of the fracture, and a 1-inch hole in each side, midway and tangent to the ¾-inch holes already drilled. It is understood that the frame is spread before the mold is applied. If possible, when a collar or band of thermit, 6 or 7 inches wide and 1 inch thick is applied around the break the frame should be spread at least 7/16 inch.

From 15 to 20 seconds after the weld is made the jack should be released to allow the frame to come together ¼ inch, holding it apart 3/16 inch until the thermit has become set; then remove the jack and let the frame resume its normal position. An instance is here given to show the results of this method. A break occurred on an Atlantic type engine, through the back of the frame at the junction of one of the rear pedestals. A collar of thermit, 7½x1¼ inches was made about the break, and after the crucible was tapped and the mold filled, the frame was immediately allowed to come together within 3/16 inch of the original length. About one hour afterward, the jack was removed, but the frame showed no sign of shortening to original length, until two hours from the time the weld was made; the heat running along the frame from 2½ to 3 feet, each side of the mold. After the frame was cold it was found by tramming that the frame was 1/64 inch longer than the original tram marks.

The writer believes a number of failures with the thermit process are due to the fact that the operator does not allow enough for contraction.

The question which no doubt is now foremost in all minds is—"What results have followed the use of thermit?" From January 14, 1905, to June 14, 1906, a period of seventeen months, welds were made as follows:

Thirty-three were made on engine frames, which are now in service; fourteen being over driving boxes. Of the above number six were rewelded, after being in service from 3 to 12 months; five of these being over driving box. These frames are all wrought iron with but one exception, which was of cast steel and was broken in a wreck.

In addition to these welds, five frames welded over the right front driving box (engines lead on the right side) were broken in service, re-welded and broken again, as the location of the fracture was such as not to permit the retention of a permanent collar of thermit. When these engines were taken into shop after the second weld broke, the section was cut out and reinforced with a new section of wrought iron. Four of them were reinforced in this manner, while the other one was replaced with a steel section, which was welded to the wrought-iron frame with thermit.

Sixteen welds were made on cast-steel driving wheels, all of which are still in service, and one weld on a steel casting for a ferry-boat.

In conclusion it may be stated that to obtain results from the thermit process, one cannot be a pessimist. Many are inclined to be skeptical inasmuch as this method is such a radical departure from the regular lines; however, in the advance of science, new processes confront us and we must ever grant a fair trial before condemnation.

*Paper presented at the fourteenth annual convention of the International Railroad Master Blacksmiths' Association, Chicago, August, 1906.

Personal

The editor would like the present address of William S. Halsey, who was formerly vice-president and general manager of the Pneumatic Crane Company, of Pittsburg, Penn.

Ignaz Lamm, of 24 Landwehrstrasse, Munich, Germany, announces that he has established business as an agent of iron and steel works and supplies for metal-working establishments. He begs that we will "wish well toward his young undertaking and commend it," which of course we do.

The firm of Robert W. Hunt & Co., of Chicago, engineers and specialists in inspection, tests of materials, etc., announce that they have engaged the services of Edward H. Lynde, who for years was connected with the Lackawanna Steel Company, in charge of their bessemer steel rail department, at Scranton, Penn. Mr. Lynde will assume direct charge of the departments of the business which were under the direction of their lately deceased partner, Albert W. Fiero. It is stated incidentally that under the terms of the partnership agreement, Mr. Fiero's widow and children will continue to enjoy the proceeds of his interest in the firm for a period of three years following his death.

Business Items

The Bristol Company, Waterbury, Conn., has established a branch office at 753 Monadnock building, Chicago, Ill.

The Latshaw Pressed Steel and Pulley Company, Pittsburg, has made arrangements with R. R. Street & Co., Chicago, to carry a large stock of the Latshaw steel split pulleys.

The Electric Controller and Supply Company, Cleveland, Ohio, announces the opening of a Chicago office in the Merchants' Loan and Trust building, 135 Adams street, Chicago, Ill., with W. M. Connelly in charge.

The Patterson Tool and Supply Company, of Dayton, Ohio, has located its Mr. A. G. Schonacker at 508 East Twenty-third street, Indianapolis, Ind., and from this location is taking care of its Indiana customers for machine tools and supplies.

The Independent Pneumatic Tool Company, of Chicago, has purchased a large plot of ground adjoining its plant at Aurora, Ill., and intends to erect theron a large building as soon as practicable and install therein the latest improved machinery suitable for the manufacture of the "Thor" tools.

Samuel S. Eveland, on behalf of the Standard Roller Bearing Company, Philadelphia, of which he is vice-president and general

manager, has purchased for that company the entire plant and real estate of the Pennsylvania Iron Works Company, which adjoins its present property. By this purchase the Standard Roller Bearing Company has secured five factory buildings with a total of over 110,000 square feet of floor space, with real estate 1600 feet by 120 feet wide, all located on the main line of the Pennsylvania Railroad and connected with the property which it now occupies, making the total length of all its property over one-half mile, with an average width of 200 feet, covering 500,000 square feet of floor surface. The cash price paid for the above property was nearly $250,000, and it will immediately be equipped with a full line of machinery at an expense of over $200,000.

Manufacturers

The Adams Tool Company, Hartford, Conn., will enlarge its plant.

The Bridgeport (Conn.) Vehicle Company will erect a new plant.

The Johnson Motor Company, Chester, Pa., will erect a new plant.

The Freen Box Company, Philadelphia, Pa., will erect a new factory.

The Detroit Bag Company, Detroit, Mich., will erect a new factory.

The Hubbard Motor Company, Middletown, Conn., will erect a new factory.

The New York Central Railroad will build repair shops at West Albany, N. Y.

The Lull Carriage Company, Grand Rapids, Mich., is building a $25,000 addition.

The W. & J. Knox Net and Twine Company, Baltimore, Md., will erect a $16,000 addition.

The Warner Instrument Company, Beloit, Wis., will build a new plant in South Beloit.

The Graton & Knight Manufacturing Company, Worcester, Mass., will erect a five-story tannery.

The American Net and Twine Mills, Anniston, Ala., will spend $400,000 in enlarging the plant.

The Root & Van Dervoort Engineering Company, Moline, Ill., will triple the capacity of its plant.

The Bay State Tap and Die Company, Mansfield, Mass., is building an addition to its factory.

The American Car and Foundry Company, Berwick, Pa., will spend $100,000 in improving the plant.

The plant of the Mill Grove (Ind.) Glass Company, recently destroyed by fire, will be rebuilt at once.

Washburn & Hayden, Brockton, Mass., will rebuild their planing mill, which burned a short time ago.

The Southern Trunk Company, Knoxville, Tenn., will move to Vestal, where a new plant will be erected.

John A. Roebling Sons' Company, Trenton, N. J., will build a $5000 and a $10,000 addition to its plant.

The Turner, Day & Walworth Handle Company, of Louisville, Ky., will put up a plant in Paragould, Ark.

The American Belting Company, Youngstown, Ohio, has let contracts for the erection of a new building.

The Waterbury (Conn.) Clock Company is making arrangements to erect a new factory in the near future.

The B. M. Root Company, York, Pa., manufacturer of woodworking machinery, will build a new factory.

The Pennsylvania Railroad Company has invited estimates on the erection of an ice plant in Philadelphia.

The Watervliet (N. Y.) Machine and Foundry Company has awarded contract for the erection of a new plant.

The Fulton Bag and Cotton Company, of Atlanta, Ga., will erect a factory and warehouse in Dallas, Texas.

The Williams Valve Company, Cincinnati, Ohio, has purchased a larger factory, having outgrown its present one.

The San Diego (Cal.) Cracker and Candy Company, recently organized, has taken out a permit for a $25,000 factory.

A new plant is being constructed for R. W. Whitehurst & Co., Norfolk, Va., manufacturers of agricultural implements.

Miller Brothers, of Rochester, Mich., will erect a factory in Detroit for the manufacture of acetylene-gas generators.

The Curtis-Leger Fixture Company, manufacturers of metal display fixtures, etc., Chicago, Ill., will erect a new factory.

Engelbert Fisher, proprietor of the Fisher Machinery Company, Chicago, Ill., will build a new machine shop, to cost $15,000.

It is reported that the Iroquois Iron Company, Buffalo, N. Y., has purchased land in Eddystone, Pa., and will locate there.

The Caldwell & Drake Iron Works Company, Columbus, Ind., is building an addition for the purpose of doing electroplating.

The West Boylston Manufacturing Company, East Hampton, Mass., manufacturing cotton and yarn, will erect another mill.

A factory building, to cost $110,000, will be erected for the Erben-Harding Company, Philadelphia, Pa., manufacturers of yarns.

The Chester (W. Va.) Ice and Water Company is being formed. Capital $25,000. Geo. C. Pugh, Robert Hobbs, etc., incorporators.

William Hollingsworth, machinist, Baltimore, Md., will erect a three-story addition and make other improvements to his plant.

Mackintosh, Hemphill & Co., Pittsburg, Pa., are building an addition to their plant to replace the pattern shop burned some time ago.

David Peoples obtained a permit for the erection of an engine and boiler house to cost $114,000 for the city of Philadelphia, Pa.

Miller & Miller, Richmond, Va., manufacturers of doors, sash, blinds, etc., will move to Manchester, Va., where a larger plant will be erected.

The Prescott Company, Menominee, Mich., builders of sawmills and mining machinery, will build an addition to the foundry recently constructed.

Catalogs

Fay & Scott, Dexter, Maine. Catalog describing standard engine lathes. Illustrated, 6x8 inches, 36 pages, paper.

The Lombard-Replogle Engineering Co., Akron, O. Bulletin "A," illustrating and describing water-wheel governor.

Baxter D. Whitney & Son, Winchendon, Mass. Catalog of wood-planing machines. Illustrated, 6x8 inches, 24 pages, paper.

The Cincinnati Lathe and Tool Co., Cincinnati, O. Circular illustrating and describing 16-inch instantaneous-change-gear engine lathe.

The Crocker-Wheeler Co., Ampere, N. J., is sending out a card giving a list of the 300 words recommended by the Simplified Spelling Board.

United States Gutta Percha Paint Co., Providence, R. I. Catalog describing Rice's XXth Century finishes for machinery. Illustrated, 6x9 inches, 24 pages, paper.

Jacques Baszanger & Co., 108 Fulton St., New York. Price list of steel set diamond tools, wire draw plates, setting diamonds, etc. 3½x6 inches, 8 pages, paper.

Patterson, Gottfried & Hunter, Ltd., 146-150 Center St., New York. Unique circulars, in which the merits of the Champion auto repair kit and high-low-jack are set forth in verse. Illustrated.

T. R. Almond Manufacturing Company, 83 Washington St., Brooklyn, N. Y. Booklet, entitled "Light Where You Want It," which describes the Almond portable electric lamp. Illustrated, 4x9 inches, paper.

Baird Machine Co., Oakville, Conn. Circulars illustrating and describing No. 1 bench press and No. 2 pendulum foot press. Catalog C, describing oblique tilting tumbling barrels. Illustrated, 6x9 inches, 7 pages, paper.

Charles H. Besly & Co., 15-21 South Canal street, Chicago, Ill. 1906 catalog of spiral disk grinders, band grinders, Helmet spiral-grinding circles, oil cups, die stocks, taps, etc. Illustrated, 6x9 inches, 56 pages, paper.

Manufacturing Equipment and Engineering Co., 209 Washington St., Boston, Mass. Catalog of metal shop and factory equipment, including sanitary wash bowls, stools, etc. Illustrated, 3½x6 inches, 16 pages, paper.

Patterson, Gottfried & Hunter, Ltd., 146-150 Center St., New York. Dealers' and jobbers' catalog No. 77. This is a voluminous book, gotten out in the loose-leaf form, encased in a leather binder, 8½x9 inches. Illustrated.

Bickford Drill and Tool Company, Cincinnati, Ohio. 1906 Catalog of radial drills. This is a very attractive book, printed on good coated paper and contains excellent half-tone engravings. Illustrated, 6x9 inches, 42 pages, paper.

Miscellaneous Wants

Advertisements will be inserted under this head at 25 cents a line each insertion. Copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded.

Caliper cat. free. E. G. Smith, Columbia, Pa.

Will buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

Light, fine machry. to order; models and elec. work specialty. E. O. Chase, Newark, N. J.

Tools, dies and special machinery built by contract. Chas. Crabb Co., 635 Kent avenue, Brooklyn, N. Y.

Gas engines designed to order. Marine and automobile work a specialty. H. L. Towle, 150 Nassau street, New York.

Special machinery accurately built. Screw machine and turret-lathe work solicited. Robt. J. Emory & Co., Newark, N. J.

Wanted—A spur-gear cutter, 60 in.; must be in good condition. Address, giving full particulars, Box 152, AMERICAN MACHINIST.

Wanted — Special screw-machine work up to 1 inch diameter; press work up to 5 inches diameter. Inventor's Mfg. Co., 134 Eliot St., Boston, Mass.

Work wanted for a Cleveland automatic lathe; handles 2 in. and under. The Earle Gear and Machine Co., 141 Oxford street, Philadelphia, Pa.

I can make your machine a success; solving mechanical problems is my specialty; wish improvement on present position. Box 170, AMERICAN MACHINIST.

We wish to hear from a party having a good hardware specialty to manufacture; something with an established market. We believe we can interest you. Wolverine Mfg. Co., Pittsburg, Pa.

Cutting-off machines wanted—6, 8 and 10-inch cutting-off machines desired; Hurlbut & Rogers preferred; give age, size, condition and price. Standard Roller Bearing Co., Philadelphia, Pa.

A large English firm of machine-tool importers, having showrooms and offices in France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMERICAN MACHINIST.

Draftsmen, engineers, graduates—Join the Automobile Designing School and earn $30 to $60 a week. Positions waiting for you. Day and evening classes and by mail. New classes now starting. Write for prospectus. The Automobile Designing School, 1416 Broadway, New York City.

Tool catalog No. 22, 950 pages bound in cloth. Greatest small-tool catalog ever published. Will be sent post-paid on receipt of $1. Money paid for catalog refunded with

first purchase amounting to $10 or over. Book costs you nothing if you become a customer. Montgomery & Co., 109 Fulton street, New York City.

Superintendent — Concern manufacturing sawmill machinery wants man thoroughly familiar with foundry machinery and carpenter shops to reorganize its factory so as to get best service out of all machines; must also have good general knowledge of transmission machinery; this is a new plant and model in every way; salary $2000. Hapgoods, 305 Broadway, N. Y.

For Sale

For Sale—Foundry, wood and iron machine shop. Box 74, Albion, N. Y.

For Sale—Wood-patternmaking business in New York City. Box 146, AMER. MACHINIST.

For Sale—Screened charcoal to be used in case hardening. Box 26, R. D. Route 1, Stafford Springs, Conn.

For Sale—Complete files of the AMERICAN MACHINIST, 1888 to 1903, inclusive. Box 162, AMERICAN MACHINIST.

Cleveland automatic lathe for sale, size 2 in.; has been used but little and is in excellent condition. Box 145, AMER. MACHINIST.

For Sale—Small gasolene (marine) engine plant in central New York; rushed with orders. Write for particulars. Address S. K. Gibbs, Schenectady, N. Y.

A 20-h.p. gas engine for sale cheap; has been used only 18 months and in good running order; a bargain. The Lapointe Machine Tool Company, Boston, Mass.

$50,000 buys plant, manufacturing own patented machines, in operation throughout the country, including patents, machinery, factory, tools, jigs, good will; 15 miles from New York City; doing good business. Box 958, AMERICAN MACHINIST.

Business Opportunities

Old electric-light-power company wants active business or technical man to buy half interest in company; one man now owns it. Box 188, AMERICAN MACHINIST.

Large lead and plumbing supply manufacturing and jobbing company wants treasurer who will buy substatial interest; salary $5000. Box 187, AMERICAN MACHINIST.

We can build machinery for quick delivery. A shop building machine tools wishes to take contracts for the construction of machinery or anything that can be produced in a foundry and machine shop. Send drawings and specifications and estimates will be made with guarantee of quick delivery. We can refer to a standard line of tools now on the market as to the quality of workmanship. Box 75, AMERICAN MACHINIST.

Wants

Situations and help advertisements only inserted under this head. Rate 25 cents a line for each insertion. About six words make a line. No advertisements under two lines accepted, and no advertisements abbreviated. The cash and copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. Original letters of recommendation or other papers of value should not be enclosed to unknown correspondents. Only bona fide situation want or help want advertisements inserted under this heading. Agency advertisements must be placed under Miscellaneous Wants.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

CANADA.

Position wanted by man aged 35; has had 18 years' experience in machine shop, nine years of which time was on gasolene engines; have owned and operated shop and handled men for the past 13 years. Box 158, AM. M.

CONNECTICUT.

Superintendent of an extensive manufacturing plant desires to make a change; accustomed to the latest and best machine-shop methods and practice; capable of organizing and handling a machinery plant in all its branches; a designer of special and automatic machinery, tools, jigs and fixtures for the rapid and economical production of fine and medium heavy interchangeable work. Box 86, AMERICAN MACHINIST.

ILLINOIS.

Designing draftsman, with experience on machine tools, special machinery, jigs, fixtures and small tools; technical, practical and original. Address Box 194, AMER. MACH.

INDIANA.

Situation wanted—Superintendent or assistant; young man; technical education; practical experience, familiar with high-speed modern methods, tools, jigs, fixtures for rapid, accurate production of duplicate, interchangeable parts on small and medium size work; references. Box 172, AMERICAN MACHINIST.

MARYLAND.

Superintendent, good executive and business ability; expert mechanic; can make your plant pay; am now employed. Box 173, AMERICAN MACHINIST.

NEW JERSEY.

Experienced mechanical draftsman wishes position. Box 171, AMERICAN MACHINIST.

NEW YORK.

Technical school graduate, five years' experience, wishes position with manufacturing engineering concern. Box 166, AMER. MACH.

Mechanical draftsman, familiar with machinery, furnaces and structures, wishes positon. Box 157, AMERICAN MACHINIST.

Office man, 27, experienced in bookkeeping and cost accounting, desires change; 11 years with present concern, machine-tool builders and general machinists. Box 179, AM. M.

Machine-shop foreman, with broad experience on the building of special machinery, is open for engagement, New York City or Jersey side preferred. Box 174, AMER. MACH.

Situation wanted as foundry superintendent by man of ability and experience in all branches of the business; a practical mechanic and manager of men; 15 years' experience as foreman; 36 years old. Box 169, AMERICAN MACHINIST.

Superintendent of manufacturing plant, by an expert of long and varied experience; exceptional ability in design and systematic production of light and medium interchangeable parts, tools and fixtures for producing the same. Box 167, AMERICAN MACHINIST.

If a specialist, who has constantly to face new problems in mechanical engineering, requires an assistant, I have had wide, general experience at home and abroad and would be glad to hear from him. Please state salary limits. Box 176, AMERICAN MACHINIST.

A man of wide general experience, covering high-speed steam engines, tin-can machinery, die-work, steam turbines, and patent work, with training as machinist, patternmaker and designer, desires connection with a first-class consulting firm, or other to fill position of responsibility. Box 177, AMER. MACHINIST.

PENNSYLVANIA.

Mechanical draftsman wants position; technical graduate, 3 years' shop experience and 5 years in the drafting room on machine design and general engineering work. Box 185, AMERICAN MACHINIST.

Wanted — Position as hydraulic and mechanical engineer; A-1 expert and designer on hydraulic machinery and tools for heavy and light forgings of all kinds and railroad steel cars; 20 years' all-around experience; age 40; with references. Box 168, AMER. MACH.

Help Wanted

Classification indicates present address of advertiser, nothing else.

CALIFORNIA.

Foreman for old established western gas-engine plant manufacturing stationary, marine and hoisting engines; must be a good organizer, able to handle men, up-to-date and able to show results; a man of experience, with good references; the right man can secure a permanent position with chance to advance soon; give full particulars. Box 121, AMERICAN MACHINIST.

CANADA.

Wanted—Experienced draftsmen on jigs, fixtures and tools; give age, experience and wages expected. Ross Rifle Co., Quebec, Canada.

CONNECTICUT.

Wanted—First-class operator on Jones & Lamson turret lathe; also one first-class all-around machinist. The New Machine Co., Danbury, Conn.

Wanted—Tool-room foreman, one who has had experience on dies for the manufacture of small parts, such as locks or electrical fittings, and who can handle eight or 10 men successfully; permanent position for the right man; write fully previous experience and salary expected. Box 186, AMER. MACHINIST.

DELAWARE.

First-class draftsman wanted; one having experience in machine tools preferred. Apply, stating experience and salary expected, to Betts Machine Co., Wilmington, Del.

ILLINOIS.

Wanted—Inspectors on very accurate interchangeable work. To any young men who are holding similar positions and are anxious to better their conditions we can offer good wages and steady employment with a growing concern. Box 163, AMERICAN MACHINIST.

Wanted—Foreman to take charge of a department assembling very accurate, complicated mechanisms. This is an exceptional opportunity for a young man with good ideas and mechanical ability; good wages; permanent position; correspondence confidential. Box 164, AMERICAN MACHINIST.

Mechanical draftsman wanted—A man with wide experience, thoroughly familiar with machinery drafting, and who has executive ability to take position as assistant of a large mechanical drafting department; prefer a man of college education; in answering, state age, experience and such other information as would be helpful in passing upon your application. Address all replies to Box 183, AMERICAN MACHINIST.

INDIANA.

Wanted—An up-to-date machine-shop foreman; one who has made a success and can give good references. Box 126, AMER. MACH.

Wanted—Experienced engine erectors for permanent employment in one of the largest engine-manufacturing concerns in the country. Address Box 147, AMERICAN MACHINIST.

MASSACHUSETTS.

Wanted—Draftsmen and tracers on printing-press work; state age, experience and salary required. Address Box 197, AM. MACH.

Wanted—First-class machinists on automobile work. Apply to manager, Waltham Mfg. Co., makers of Orient automobiles, Waltham, Mass.

Wanted — First-class toolmakers, milling machine, floor and vise hands on high-grade medium weight machinery; good pay and permanent positions to competent workmen. Box 85, AMERICAN MACHINIST.

A growing machine shop, wishing to add to its line of work, invites correspondence with a man sufficiently expert in some profitable line (machine tools preferred) to introduce its manufacture, and later to attend to the sales and installation work. To such a man a liberal salary will be paid on demonstration of ability to make good. Box 98, AM. MACH.

Wanted—Two first-class machinists; must be capable of doing light, fine machine work; no common, rough workmen will answer. For competent men we can offer permanent positions; light, pleasant shop, 20 miles from Boston. In answering, state age, experience and wages expected. Replies will be held strictly confidential. Box 112, AMER. MACH.

Wanted—An assistant to general foreman of machine shop; 300 men; one who can be in line to assume general foreman's duties when called upon; must be energetic, ambitious and familiar with up-to-date methods of handling men and getting work out rapidly and economically; if interested, give synopsis of experience, stating age and compensation expected. Box 190, AMER. MACHINIST.

MICHIGAN.

Wanted — Automatic screw-machine hand. Address 266 Abbott St., Detroit, Mich.

Wish to correspond with two draftsmen having experience of at least four years; must be familiar with boiler settings and general boiler work. Address "F. F.," Box 103, AMERICAN MACHINIST.

Wanted—A man capable of designing sawmill machinery and laying out complete installations. Must have experience of at least eight or ten years and be thoroughly practical. Address "G.," Box 102, AMER. MACH.

Wanted—Potter & Johnston machine hand; must be good mechanic and thoroughly understand the above machines and capable of getting good results from same. Address Continental Motor Mfg. Co., Muskegon, Mich. State wages wanted.

NEW JERSEY.

Wanted—Mechanical draftsmen; location, Newark, N. J.; state experience and salary expected. Box 122, AMERICAN MACHINIST.

Wanted—A sober, skilled and reliable machine blacksmith; wages satisfactory; reference required. Address Box 191, AM. MACH.

Several first-class tool and diemakers accustomed to high-grade work; steady employment and good wages to competent men. Sloan & Chace Mfg. Co., Sixth avenue and Thirteenth street, Newark, N. J.

We are increasing our tool-making department and solicit applications from toolmakers and machinists who are experienced on fine and complicated work. Apply to Victor Talking Machine Co., Camden, N. J.

We have increased our plant and desire floor and vise hands for day work and lathe hands for night work. Good pay and steady work to good men. Address or apply at Pond Machine Tool Co., Plainfield, N. J.

NEW YORK.

First-class jig designers wanted. Box 160, AMERICAN MACHINIST.

Wanted—First-class checker of drawings for general machine work. Box 195, AM. M.

Wanted—Experienced men on general tool work; steady positions for the right men. Remington Typewriter Factory, Ilion, N. Y.

Wanted — Experienced draftsmen, toolmakers and machinists. Give age, references and wages expected. Remington Arms Co., Ilion, N. Y.

Wanted, immediately, machinists; must be good lathe hands; applicants must give wages expected. Address "P. C. W.," Alsen, Greene Co., N. Y.

Wanted—A young man as draftsman, experienced on small tools and automatic machinery. Answer, stating experience and salary expected, "J. S.," Box 151, AM. MACH.

Wanted—Patternmaker, first-class man, by small manufacturing concern; good position and steady employment for right man; state experience and wages. Box 159, AM. MACH.

Mechanical draftsman wanted for detail and construction work, capable of speed and judgment on general design; state salary and experience. "X," Box 148, AMER. MACHINIST.

Machine-shop foreman wanted—A capable young man who is looking for hard work and advancement to correspond; send your experience and references. Box 180, AMER. MACH.

Wanted—Mechanical and electrical draftsmen. Apply, giving age, experience and salary expected, Engineer in Charge, Drafting Department, General Electric Co., Schenectady, N. Y.

Wanted—Chief draftsman, accurate, with executive ability and extensive experience in Webb printing-press designing; to a competent man we can offer a permanent position at a good salary. Apply Box 182, AM. M.

Wanted—A man as foreman of machine department and master mechanic of a manufacturing plant in central New York; machine department has about 20 men. Address, stating age, experience and salary required, Box X 181, AMERICAN MACHINIST.

Wanted—A salesman for machine tools; must be a thorough mechanic of good address and willing to travel most of the time, residing at or near Philadelphia; answer in hand-written letter, stating age, experience and qualifications. Box 184, AMER. MACH.

Competent male double-entry bookkeeper wanted by growing New York concern; experience in iron and steel or machinery lines preferred; opportunity for proper person; to receive attention, state age, experience and salary expected. Steel Merchant, Box 175, AMERICAN MACHINIST.

NORTH CAROLINA.

Wanted—An all-around machinist to work in repair shop; state age, experience and wages expected. Box 193, AMER. MACH.

OHIO.

Our growing business constantly requires additional machinists. We build lathes, planers, shapers, drilling machines; good opportunity for machinists. The American Tool Works Co., Cincinnati.

Wanted—A man of executive ability and long experience on universal grinders to take charge of grinding job in toolroom of a large manufacturing establishment in the middle West. Address Grinder, Box 192, AM. MACH.

Wanted—A young man to do detail work on gasolene engines; to one who is thoroughly familiar with this class of work, first-class wages will be paid; none but hustlers need apply. Address Box 178, AMERICAN MACH.

The National Metal Trades Association can place a few first-class toolmakers, patternmakers and blacksmiths. Positions will be guaranteed as steady and at highest prevailing rate of wages. This is an opportunity for first-class men to secure one of the N. M. T. A. certificates of recommendation. For further particulars address The National Metal Trades Association, Cincinnati, O.

Works manager wanted—A first-class man to manage the factory of an established and up-to-date manufacturing concern located in Ohio, employing about 500 men; must, in addition to having an extensive practical experience in modern shop methods, have sufficient technical education to handle the engineering problems that arise in foundry and machine-shop practice. Write, giving age, complete factory and technical experience and approximate salary required. Box 155, AM. M.

PENNSYLVANIA.

Hammerman wanted for drop-forge work; 1000-lb. Bliss hammer. Box 150, AM. MACH.

Wanted—Ten machinists, lathe, planer, boring mill and bench hands; steady work. Apply to Scottdale Foundry & Machine Co., Scottdale, Pa.

Wanted—Foreman for boiler shop employing 75 to 125 men; one who can handle men to advantage and get out first-class work at a minimum cost; shop located in western Pennsylvania. Box 161, AMER. MACHINIST.

The Monotype Company maintains a free school for training young machinists to operate its type casting and composing machines. The demand for monotype operators is so great that it receives more applications for places in its school than can be filled. In making selections these qualifications carry most weight: Character, common sense, experience with automatic machinery (or) printing-office experience, or type-foundry experience. Full particulars will be furnished to inquirers who furnish full particulars about themselves. Lanston Monotype Machine Co., 1231 Callowhill St., Philadelphia, Pa.

RHODE ISLAND.

Toolmakers wanted — First-class workmen on jig and fixture work for light high-grade machinery. Permanent employment to competent workmen. Apply to the Taft-Peirce Mfg. Co., Woonsocket, R. I.

WISCONSIN.

Wanted—Machinists, lathe, planer, shaper and drill-press hands, vise, floor and handy men. Apply A. B. C., Box 96, AMER. MACH.

Wanted—A first-class machinist for the position of foreman; a hustler; no others need apply; good wages and steady work in a Wisconsin city. Box 156, AMER. MACHINIST.

To cope with the continuous enlargement of our business, first-class machinists, patternmakers, molders and boilermakers can find steady employment. Box 899, Milwaukee, Wis.

Machinists wanted to inspect and assemble automobile transmissions; experienced men desired, but men able to construct any good machinery will find desirable employment; open shop. Address Thomas B. Jeffery & Company, Kenosha, Wis.

Foundry superintendent is wanted for manufacturing company in middle West, melting 100 tons iron a day; a live up-to-date man is wanted, with experience on both large and small work; open shop; molding machines extensively used; beautiful small city. Address Box 153, AMERICAN MACHINIST.

Large concern building excavating and railway machinery wants to correspond with first-class mechanical draftsmen with view to filling future vacancies as they occur; wants men now employed; give full experience and reason for changing; shop experience great advantage; all letters acknowledged and held confidential. Box 919, AMERICAN MACHINIST.

The Fairbanks-Morse Manufacturing Company, at Beloit, Wis., is constantly increasing its works and can use a large number of first-class mechanics, such as machinists, molders, patternmakers and erecting engineers, to work on gas and gasolene engines, steam pumps and hydraulic machinery. Address Fairbanks-Morse Mfg. Company, Beloit, Wisconsin.

WEST OF MISSISSIPPI.

Instrument maker competent to make mechanical repairs to Thomson and Weston instruments; state experience and wages expected; chance for promotion. Box 165, AMERICAN MACHINIST.

Wanted—Competent foundry foreman, capable of making chilled cast iron and hard white iron; must give best references; interest in business for right man. Box 154, AMERICAN MACHINIST.

FOREIGN.

General superintendent (American) for large automobile plant in Paris; must be thoroughly up-to-date for quick interchangeable work at lowest cost; the best is not too good; proved capacity of greater importance and will be considered before salary; knowledge of French language useful, but capacity for output the principal point. Reply, giving fullest particulars, to J. Ryan, 78 Avenue de la Grand Armée, Paris, France.

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Sturtevant Co., B. F., Hyde Park, Mass.

Blue Print Machines

General Electric Co., New York.

Boilers

Chandler & Taylor Co., Indianapolis, Ind.
Struthers-Wells Co., Warren, Pa.

Bolt and Nut Machinery

Acme Machry. Co., Cleveland, O.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Boynton & Plummer, Worcester, Mass.

Bolt and Nut Machinery—*Continued.*

Detrick & Harvey Mach. Co., Baltimore, Md.
Foote, Burt & Co., Cleveland, O.
Harrington & Son Co., Edwin, Philadelphia, Pa.
Landis Machine Co., Waynesboro, Pa.
Northern Elec. Mfg. Co., Madison, Wis.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Machinery Co., Bowling Green, Ohio.
Standard Engineering Works, Ellwood City, Pa.
Vandyck Churchill Co., New York.
Waterbury Farrel Fdry. & Mach. Co., Waterbury, Conn.
Wells Bros. Co., Greenfield, Mass.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Bolts, Coupling

National-Acme Mfg. Co., Cleveland, O.

Bolts and Nuts

National-Acme Mfg. Co., Cleveland, O.

Books, Mechanical

American School of Correspondence, Chicago, Ill.
Henley Pub. Co., Norman W., New York.
Hill Publishing Co., New York.
Neumayer, M., Cincinnati, O.
Sames, C. M., Jersey City, N. J.
Wiley & Sons, Jno., New York.

Boosters

Burke Electric Co., Erie, Pa.
C & C Electric Co., New York.
Crocker-Wheeler Co., Ampere N. J.
General Electric Co., New York.
Northern Elec. & Mfg. Co., Madison, Wis.

Boosters—*Continued.*
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sprague Elec. Co., New York.
Stanley-G. I. Electric Mfg. Co. Pittsfield, Mass.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Boring and Drilling Machines, Horizontal
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Betts Mach. Co., Wilmington, Del.
Binsse Mach. Co., Newark, N. J.
Boynton & Plummer, Worcester, Mass.
Detrick & Harvey Mach. Co., Baltimore, Md.
Fitchburg Machine Works, Fitchburg, Mass.
Fosdick Mach. Tool Co., Cin., O.
Gisholt Mach. Co., Madison, Wis.
Hill, Clarke & Co., Boston, Mass.
Lucas Mach. Tool Co., Cleveland, Ohio.
McCabe, J. J., New York.
Motch & Merryweather Machinery Co., Cleveland, O.
Newton Mach. Tool Wks., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Pawling & Harnischfeger, Milwaukee, Wis.
Prentiss Tool & Supply Co., New York.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.
Warner & Swasey Co., Cleveland, Ohio.
Whitcomb-Blaisdell Mach. Tool Co., Worcester, Mass.

Boring and Turning Mills
American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Baush Mach. Tool Co., Springfield, Mass.
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Betts Mach. Co., Wilmington, Del.
Bullard Mach. Tool Co., Bridgeport, Conn.
Colburn Mach. Tool Co., Franklin, Pa.
Gisholt Mach. Co., Madison, Wis.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hill,Clarke & Co. Boston, Mass.
King Mach. Tool Co., Cincin., O.
McCabe, J. J., New York.
Niles-Bement-Pond Co., New York.
Poole Co., J. Morton, Wilmington, Del.
Prentiss Tool & Supply Co., New York.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Vandyck Churchill Co., New York.
Warner & Swasey Co., Cleveland, Ohio.

Boring Tools
Armstrong Bros. Tool Co., Chicago, Ill.

Brackets, Lamp
Standard Welding Co., Cleveland, Ohio.

Bulldozers
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Prentiss Tool & Supply Co., New York.

Cabinets, Tool
Armstrong Bros. Tool Co., Chicago, Ill.
Athol Machine Co., Athol, Mass.
Hammacher, Schlemmer & Co., New York.

Calipers
Athol Machine Co., Athol, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Mass. Tool Co., Greenfield, Mass.
Slocomb Co., J. T., Providence, R. I.
Starrett Co., L. S., Athol, Mass.

Cams
Boston Gear Wks., Boston, Mass.

Carborundum
See Grinding Wheels.

Castings, Brass and Bronze
Lumen Bearing Co., Buffalo, N. Y.

Castings, Die Molded
Franklin Mfg. Co., H. H., Syracuse, N. Y.

Castings, Iron
Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Poole Co., J. Morton, Wilmington, Del.
United Engineering & Fdry Co., Pittsburg, Pa.

Castings, Malleable
Bancroft & Co., Philadelphia, Pa.

Castings, Steel
Bancroft & Co., Philadelphia, Pa.
Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Kent & Co., Edwin R., Chicago, Ill.

Cement, Cast Steel
Clark Cast Steel Cement Co., Shelton, Conn.

Centering Machines
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Hendey Mach. Co., Torrington, Ct.
Hill, Clarke & Co., Boston, Mass.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Whiton Machine Co., D. E., New London, Conn.

Centers, Planer
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Woodward & Powell Planer Co. Worcester, Mass.

Chains, Driving
Baldwin Chain & Mfg. Co., Worcester, Mass.
Boston Gear Wks., Boston, Mass.
Diamond Chain & Mfg. Co., Indianapolis, Ind.
Jeffrey Mfg. Co., The, Columbus, Ohio.
Link-Belt Co., Philadelphia, Pa.
Morse Chain Co., Ithaca, N. Y.
Whitney Mfg. Co., Hartford, Ct.

Chisels, Cold
Hammacher, Schlemmer & Co., New York.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Chucking Machines
American Tool Works Co., Cincinnati, O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Automatic Machine Co., Cleveland, O.
Gisholt Mach. Co., Madison, Wis.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Potter & Johnston Mach. Co., Pawtucket, R. I.
Warner & Swasey Co., Cleveland, Ohio.
Whitcomb-Blaisdell Mach. Tool Co., Worcester, Mass.
Windsor Mach. Co., Windsor, Vt.

Chucks, Drill
Almond Mfg. Co., T. R., Brooklyn, N. Y.
Brown & Co., R. H., New Haven, Conn.
Cleveland Twist Drill Co., Cleveland, O.
Cushman Chuck Co., Hartford, Conn.
Goodell - Pratt Co., Greenfield, Mass.
Horton & Son Co., E., Windsor Locks, Conn.
Jacobs Mfg Co., Hartford, Conn.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Niles-Bement-Pond Co., New York.
Pratt Chuck Co., Frankfort, N. Y.
Standard Tool Co., Cleveland, O.
Trump Bros. Mach. Co., Wilmington, Del.
Whitney Mfg. Co., Hartford, Ct.
Whiton Mach. Co., D. E., New London, Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Chucks, Lathe
Cushman Chuck Co., Hartford, Conn.
Gisholt Mach. Co., Madison, Wis.
Hoggson & Pettis Mfg. Co., New Haven, Conn.

Chucks, Lathe—*Continued.*
Horton & Son Co., E., Windsor Locks, Conn.
Niles-Bement-Pond Co., New York.
Scott & Sons Co., Medford, Mass.
Skinner Chuck Co., New Britain, Conn.
Whiton Mach. Co., D. E., New London, Conn.

Chucks, Planer
Niles-Bement-Pond Co., New York.
Skinner Chuck Co., New Britain, Conn.
Westcott Chuck Co., Oneida, N. Y.

Chucks, Split
Rivett Lathe Mfg. Co., Boston, Mass.
Westcott Chuck Co., Oneida, N. Y.

Circuit Breakers
Crocker - Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Stanley-G. I. Electric Mfg. Co. Pittsfield, Mass.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Clamps
Billings & Spencer Co., Hartford, Conn.
Hoggson & Pettis Mfg. Co., New Haven, Conn.

Clutches, Friction
Caldwell, Son & Co., H. W., Chicago, Ill.
Cresson Co., Geo. V., Phila., Pa.
Johnson Mach. Co., Carlyle, Hartford, Conn.
Link-Belt Co., Philadelphia, Pa.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Wood's Sons Co., T. B., Chambersburg, Pa.

Coal Handling Machinery
Link-Belt Co., Philadelphia, Pa.

Coils
Standard Welding Co., Cleveland, Ohio.

Compound, Pipe Joint
Dixon Crucible Co., Jos., Jersey City, N. J.

Compressors, Air
Blaisdell Machinery Co., Bradford, Pa.
Blanchard Mach. Co., Boston, Mass.
Bury Compressor Co., Erie, Pa.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Ingersoll-Rand Co., New York.
Mietz, August, New York.
Spacke Machine Co., F. W., Indianapolis, Ind.

Compressors, Gas
Ingersoll-Rand Co., New York.

Condensers
Stanley-G. I. Electric Mfg. Co., Pittsfield, Mass.

Conduit, Interior
Sprague Electric Co., New York.

Cones, Friction
Evans Friction Cone Co., Boston, Mass.

Connecting Rods and Straps
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Contract Work
Blanchard Mach. Co., Boston, Mass.

Controllers and Starters, Electric Motor
Case Mfg. Co., Columbus, Ohio.
Crocker - Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Stanley-G. I. Electric Mfg. Co., Pittsfield, Mass.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Coping Machines
Bertram & Sons Co., Ltd., John, Dundas, Ontario, Canada.
Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.

Cork Inserts
National Brake & Clutch Co., Boston, Mass.

Correspondence Schools
See Schools, Correspondence.

Cotters
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Counterbores
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Slocomb Co., J. T., Prov., R. I.

Counters, Machinery
Veeder Mfg. Co., Hartford, Conn.

Countershafts
Almond Mfg. Co., T. R., Brooklyn, N. Y.
Builders' Iron Fdry., Prov., R. I.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Mossberg Wrench Co., Central Falls, R. I.
Smith Countershaft Co., Boston Mass.

Countershafts, Friction
Wilmarth & Morman Co., Grand Rapids, Mich.

Countershafts, Speed Changing
Cresson Co., Geo. V., Phila., Pa.
Gisholt Mach. Co., Madison, Wis.
Speed Changing Pulley Co., Indianapolis, Ind.

Counting and Printing Wheels
Franklin Mfg. Co., H. H., Syracuse, N. Y.

Coupler, Hose
Ingersoll-Rand Co., New York.

Couplings, Shaft
Almond Mfg. Co, T. R., Brooklyn, N Y.
Caldwell & Son Co., H. W., Chicago. Ill.
Chisholm & Moore Mfg. Co., Cleveland, O.
Cresson Co., Geo. V., Phila., Pa.
Davis Machine Co., W. P., Rochester, N. Y.
Link-Belt Co., Philadelphia, Pa.
Nicholson & Co., W. H., Wilkesbarre, Pa.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Gauge Steel Co., Beaver Falls, Pa.
Wood's Sons Co., T. B., Chambersburg, Pa.

Cranes
Alliance Machine Co., Alliance, O.
Brown Hoisting Mach. Co., New York.
Case Mfg. Co., Columbus, O.
Chisholm & Moore Mfg. Co., Cleveland, O.
Cleveland Crane & Car Co., Wickliffe, Ohio.
Crescent Forgings Co., Oakmont, Pa.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Maris Bros., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Northern Engineering Works, Detroit, Mich.
Obermayer Co., S., Cincinnati, O.
Pawling & Harnischfeger, Milwaukee, Wis.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
United Engineering & Fdry. Co., Pittsburg, Pa.
Vandyck Churchill Co., New York.
Yale & Towne Mfg. Co., New York.

Crank Pin Turning Machines
Niles-Bement-Pond Co., New York.
Underwood & Co., H. B., Philadelphia, Pa.

Crank Shafts
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

CUTTER-HEAD MECHANISM OF THE THREAD-MILLING MACHINE

Some Special Problems and Their Solution

BY A. E. TCHERNIAK

The thread-milling machine built by the Pratt & Whitney Company, of Hartford, Conn., contains solutions of some interesting mechanical problems, an analysis and description of which may prove of some interest to those engaged in machinery building. To outline these special problems and their solutions will be the object of this article; as descriptions of the machine as a whole, illustrating its general construction and giving information concerning its operation and various advantages, have already appeared in these columns.

ELEMENTS ENTERING INTO THE THREAD-MILLING PROBLEM

To produce a worm or a screw on an ordinary engine lathe, two conditions are necessary—the advancement of the cutting tool and the turning of the work. To perform the same operation by a milling process a third element must be introduced and that is the rotation of the cutter.

To cut a worm or a screw thread by a rotary cutter, the latter must be set at the same angle as the angle of inclination of the thread. But as this angle is variable within very wide limits, according to the diameter of the work and the pitch of the thread and is different for right- and left-hand threads, the setting of the cutter must be permissible within the same limits. This means that the driving of the cutter spindle must be performed in such a manner that its inclination within the necessary practical limits for right- and left-hand threads shall not affect it. In other words it is required to communicate motion to an axis inclined at a variable angle.

Such a problem would not offer great difficulties if it were not accompanied by some special features. When a thread is cut by a stationary tool, the cutting is done by the sharp edge of the tool, which can practically be considered as a point. Such a cutting edge will form in the work a perfectly true helical curve, as a result of the rotation of the work and advancement of the cutter. But if, instead of a sharp edge in the work, were to be introduced a cutting element of some length, the shape of the groove would be deformed and its section would not correspond with the section of this cutting element. Such a deviation would depend: (1) upon the curvature of the helix which in its turn is determined by the diameter of the work and the lead of the thread; (2) upon the angle or taper of the tool and (3) upon the length of the cutting element. But, as the first two factors are fixed for every given case, only the third can be changed to suit the required conditions. In the case of forming a thread by a milling cutter, the cutting is certainly done by an element of some length, and to prevent such deformation in the shape of the thread as might be of any practical importance the diameter of the cutter must be as small as possible. Of course small cutters have

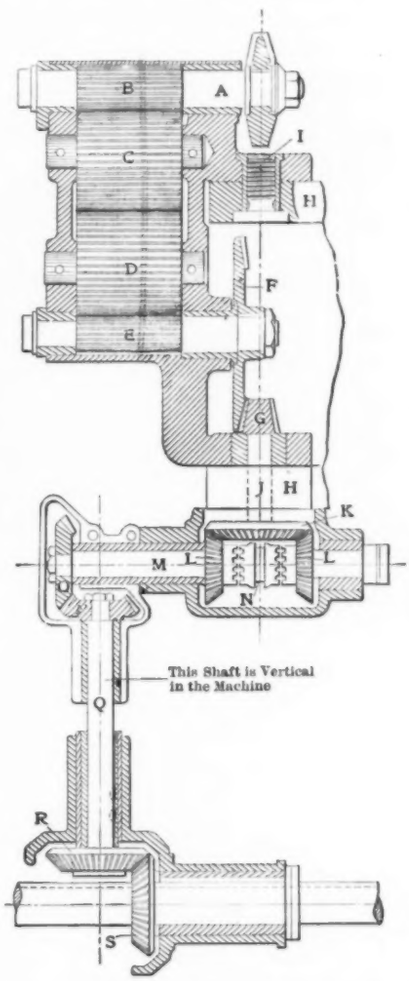


FIG. 1. THE CUTTER DRIVING MECHANISM OF THE PRATT & WHITNEY THREAD MILLER

generally important advantages; namely, they are more easily driven, having a greater angular velocity with the same peripheral velocity on one hand and are cheaper to manufacture on the other. But in this case small cutters must be considered rather a necessity than an advantage.

Taking such a statement as a basis in designing the cutter-driving mechanism of the thread miller we certainly come to the most complicated and original problem the designer of this machine had to solve.

CONDITIONS ATTENDING THE CUTTER OPERATION

Disregarding for the present the question as to how the cutter is driven, it must be admitted that the driven member in any case will be fixed on the spindle for the cutter. But as the cutter travels along the work with its axis in a plane parallel to the latter and enters the work to the depth of the thread, there is a very limited space left for the driven member which must clear the work. Therefore, the cutter must be driven by a gear considerably smaller than itself.

It is frequently required to cut screws with shoulders with the thread close up to the latter. In such cases the cutter must be brought close up to the shoulder, and that means that one side of the cutter must be free from any support, having its drive and the bearing arranged at one side.

Three more points will complete the conditions which must be considered in designing the cutter-driving arrangement and these are: first, means must be provided to change the direction of rotation of the cutter, when changing from right to left-hand threads or from left to right; second, the whole arrangement of the cutter drive must be such that it will permit the longitudinal travel of the cutter without affecting its positive connection with the initial driving point; and third, the cutter must be able to move to or from the work without its gearing being disconnected. As this transverse movement of the cutter is required very often, when multiple threads or pieces of different diameters are cut and every time the cutter is set to the exact depth of the thread, it must be effected in an easy and simple way. The above analysis shows that the cutter-driving mechanism must comprise quite a complicated mechanical combination, permitting the flexibility of the cutter in several directions; setting at an angle, transverse and longitudinal movements and reversal of the direction of rotation.

DRIVING-GEAR RATIOS, SPEEDS, ETC

To give a clearer idea of the whole problem, as represented in the above description, it will be necessary to say a few words in regard to the strains under which the parts of the cutter drive are working. This can be well illustrated by some figures taken from the heaviest model thread miller; and a section through the cutter head of this tool revealing the entire cutter-driving arrangement is given in Fig. 1. This machine, designed to thread pieces up to 48 inches long and 12 inches diameter, formed the subject of an article appearing at page 359, Vol. 28, Part II. A thread 1 inch deep and 1½-inch pitch can be cut at one operation on this miller, the cutter being 5 or 6 inches diameter. The driving shaft has a pulley

15 inches in diameter and is supposed to run at a speed of 500 revolutions per minute. To supply sufficient power a 3-inch belt is necessary. The cutter is geared from the driving shaft in a ratio of 10 to 1. Neglecting the power consumed by friction throughout the machine, we find that every member of the balanced working system of the machine experiences proportionally the same strain and therefore the resistance on the periphery of a 5-inch cutter in our case will be 15/5× 10, or 30 times as great as the grip of the 3-inch belt. The cutter is driven by a pinion 1¾ inch diameter, 19 teeth, 12 diametral pitch, and the strain on the periphery of the pinion will be 30×5/1.75 = 86 times the grip of the belt. To enable this pinion to stand such a strain salvation has been found in the length of the teeth, which is 5 inches; in the material, which is high-grade tool steel; in careful workmanship to insure contact of the teeth all along their length, and in efficient lubrication. These four factors have made possible what at first glance would seem impossible, and no trouble has been experienced in the way of wear of this part notwithstanding the considerable length of time elapsing since this size of machine was put in operation. Referring now to the drawing Fig. 1, we will follow up the construction of the cutter-driving mechanism.

ARRANGEMENT OF CUTTER DRIVE

The cutter spindle is shown at *A* and the driven pinion *B* forms a part of that spindle. Through two intermediate gears *C* and *D* the pinion *B* is connected with the pinion *E*, forming a part of a spindle on which a bevel gear *F* meshing with a bevel pinion *G* is fixed. The center line of *G* coincides with the center line of the cutter. All these gears are inclosed in a cutter head connected with the cross slide by trunnions *H*. The latter being hollow are fastened together by nuts *I* and in this manner the cutter head is fixed in position after the cutter is set to the required angle. The center line of the trunnions is of course on the same line as that of the cutter. As has been mentioned before, the ratio of the gearing between the cutter and the driving shaft is 10 to 1 and the designer's tendency was to confine the greater part of the reduction to the cutter head and accordingly the pinion *B* has 25 teeth, and *E* 19 teeth. The gears *F* and *G* are in the ratio of 11 to 2. The whole decrease in speed in the cutter head is 7.24 to 1. In such manner the strain is taken off the rest of the mechanism where the parts have a sliding movement while they are loaded.

On the shaft *J* on the end of which the teeth of *G* are cut, a bevel gear *K* is fixed, the latter engaging with gears *L L*, which are closely mounted upon the shaft *M* and can be connected with it alternatively by the clutch *N*. At this point the reversing of the direction of rotation of the cutter is accomplished.

The shaft *M*, by gears *O* and *P*, is connected with a vertical telescopic shaft *Q*, which is connected with the main driving shaft by gears *R* and *S*. The introduction of a telescopic shaft at this point permits cross movement of the slide, with which the cutter head is connected, while the gear *S* is free to slide along a feather on the main shaft, thus permitting longitudinal movement of the cutter head without disturbing the positive connection.

The arrangement of these parts on the machine can be clearly seen on the half tone Fig. 2, representing the rear view of a machine designed for lighter work.

Notwithstanding the considerable reduction of strain on the main shaft, it is still subjected to torsional strain, when long pieces are threaded and the motion to the cutter is transmitted a long distance from the main driving point, so to reduce this strain under such condition a fly-wheel is mounted close to the gears *R* and *S*.

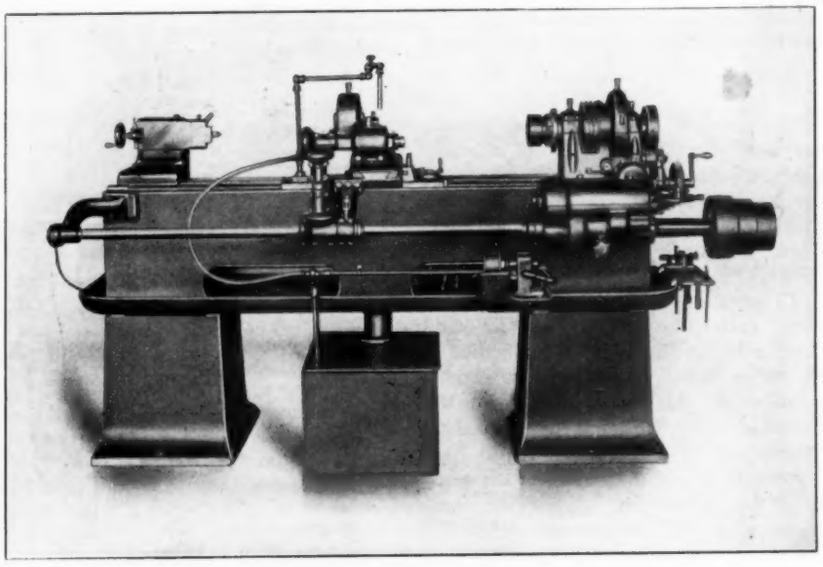


FIG. 2. REAR VIEW OF THREAD MILLER SHOWING CUTTER ACTUATING MECHANISM

FEED-SLIDE AND CUTTER-TOOTH DESIGN

Because of the strain under which all the parts work, considerable attention has been paid to the construction of the feed slide carrying the cutter head. Owing to the inclination of the cutter the force acting on the slide has a twisting effect upon the latter, and to insure an easy movement of the slide it is made in the shape of a cross, thus giving a four-point bearing. It would be outside the scope of this article to go into a full description of the machine, but it may not be out of place to conclude with a few words respecting the cutter. In consequence of the inclination of the cutter while working, the chips are liable to be carried along by its teeth, and the lubricant could not wash them off if the space between were too limited. For this reason, and to admit of ample lubrication to carry off the heat, the teeth of the cutter are staggered; that is, every other tooth is milled out in such a manner that opposite a space on one side of the cutter there is a tooth on the other, one whole tooth being left for gaging.

Formulas for Constructing Rings Made from Square or Flat Iron Bent Edgewise*

BY S. UREN

In 1904, I was chairman of the committee on reducing railroad forgings to an exact science. At that time I was not prepared to give mathematical formulas for constructing rings made from square or flat iron bent edgewise, but I have since produced formulas that will give the exact dimensions of a ring bent from square or flat iron, in its original shape before bending, also the exact dimensions of the ring after bending.

Many different methods are used by practical smiths to determine the proper length to cut the straight bar. The carriage smith will either roll the wheel over a long bar of iron or will use a small wheel and roll the outside of the wheel and the inside of the tire, making the allowance for the openings between the felloes, which method is absolutely correct. In a locomotive or manufacturing shop conditions are different, as the smith works from drawings and in many cases has no means of measuring the circumference the ring is to fit over. Oftentimes the ring has to be finished on all sides in the machine shops and the proper allowance has to be made for finishing.

Different smiths have different methods of calculating the straight length of the bar. Many use the old rule, "as 7 is to 22

*A paper read before the Railway Master Blacksmiths' Association.

so is the diameter to the circumference," others simply, "3 times the diameter plus one seventh the diameter." Then again others use the simple rule of "3 times the inside diameter plus 3 widths of the iron." The writer's method is to use the constant 3.1416 multiplied by the diameter of the ring at the neutral axis of the bar. The above methods are practically correct measuring from the center of the metal, but they do not give the short and long side of the straight bar as shown at Figs. 1, 2 and 3. I, as well as others, have searched mathematical and mechanical books for formulas that would give the

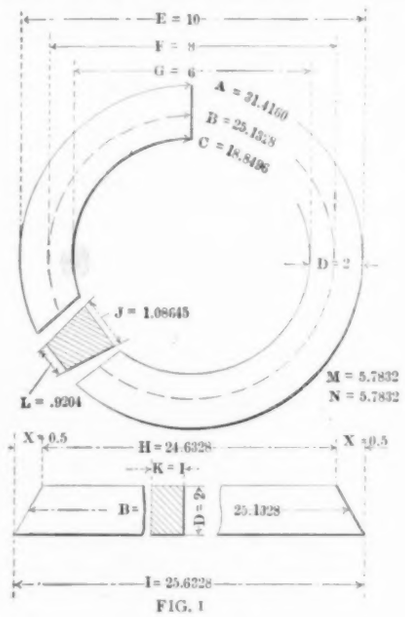


FIG. 1

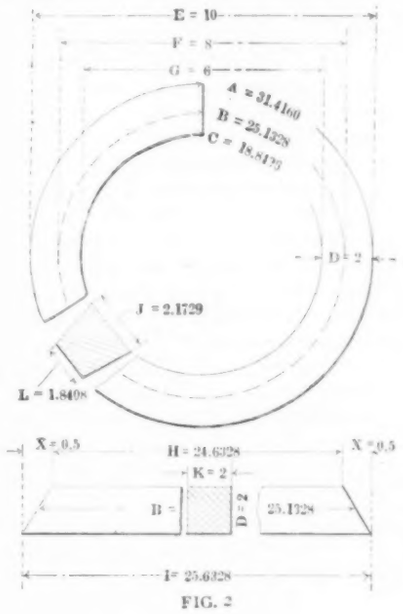


FIG. 2

FORMULAS

$$B = \pi \times F$$

$$X = \frac{E - G}{E + G} \times D$$

$$I = B + X$$

$$H = I - 2X$$

$$M = H - C$$

$$N = A - I$$

$$J = \frac{\pi \times D \times K}{M}$$

$$L = \frac{M \times K}{\pi \times D}$$

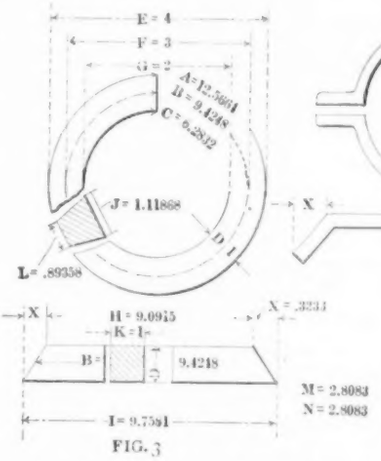


FIG. 3

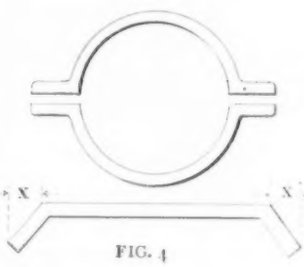


FIG. 4

different functions of a ring that has been bent from a heated bar of iron of given dimensions. I could not find anything bearing on the subject; consequently, Mr. Harkins, my assistant foreman, who is an expert mathematician, and myself, undertook to solve the problem and we have fully demonstrated and proved the resulting formula by experiments in actual practice.

Fig. 1 represents a ring bent from a bar of iron 2 inches wide by 1 inch thick. The usual custom of the practical blacksmith is to cut the bar to the length produced by the constant 3.1416 multiplied by the diameter of the ring and guess at the angle to cut the end of the bar. Oftentimes after the ring is bent, the inside will meet, leaving an opening on the outside, or if cut in excess, similar conditions obtain on the inside. In nearly all cases the smith will cut his iron long and trim it to the proper shape after bending. The formula herewith is simple and will give the angle to which the end of the bar should be cut before bending. It states that the difference between the long and short diameters divided by their sum multiplied by the width of the iron will give the required angle. The result in all cases should be added to the length produced by the above formula and the angle cut as shown at Fig. 1. If the ring is not to be welded, the ends will come together forming a perfect joint.

It will be observed from Fig. 1 that the metal changes its shape in bending. The inside circumference of Fig. 1 is 18.8496 inches. The length to produce the circumference is, as shown, 24.6328 inches, or 5.7832 inches in excess of the inside circumference of the finished ring. The reverse conditions exist in the outside of the ring. The actual length of the straight bar is 5.7832 inches shorter than the actual outside circumference of the ring, consequently the surplus metal has to be accounted for on the inside of the ring and diminished on the outside. The extra metal increases the thickness of the inside of the ring as shown at *J* and decreases the thickness of the outside as shown at *L*. Oftentimes the smith has to make rings in sections as shown in Fig. 4, for which the same formula will apply to the angle projections in the straight bar. The usual custom of the smith is to guess at the angle when forging the projections in the straight bar and set the ends properly after the section of the ring is bent. The formulas are correct if the rings are bent at an even temperature and the metal has the same tensile and compressive strength. Practically the metal has about equal tensile and compressive strength at a bright red heat. When making rings from uneven shaped iron such as T, or channel sections, the formula 3.1416 multiplied by the diameter must be figured from the neutral axis of the bar.

Fig. 1 shows a ring of 6 inches inside diameter produced from a 1x2-inch bar, and Fig. 2 a ring of the same inside diameter produced from a 2-inch square bar. The dimensions given by the formula correspond to the dimensions of similar rings produced in actual practice.

Very few smiths realize that the length of the short side of the straight bar in a 6-inch ring 2 inches wide is 5.7832 inches longer than the inside circumference of the ring and the long side as much shorter than the outside circumference. One of our members considered it a loss of time and energy to solve the ring problem, but if the formula presented herewith proves of any benefit to my fellow craftsmen I shall consider myself well paid for the time I have used in solving the ring problem. The formula to give *J* is all that is required, as what *J* is more than *K*, *L* is less than *K*. The foregoing formula applies to diameters between 1 inch and 10 feet. For large radii or railroad curves, the functions would be almost infinity.

According to the United States consular reports there are under the subject of metals a number of increases in the proposed new tariff of Japan. The raise in block and ingot copper is from 5 to 7½ per cent. and a general increase in all manufactured copper. Lead ingot raised from .316 sen to .38 sen per 100 kin. The lead imports from the United States in 1904 were $209,000 gold. Mercury raised to 7.20 yen per 100 kin. Mercury imports from the United States in 1904 were $90,250 gold. Zinc raised from 40 sen per 100 kin to 72 sen per 100 kin. Machinery for metal working raised from 10 to 15 per cent. ad valorem. It is proposed to increase the tariff on watches from 30 per cent. present rates to 50 per cent. ad valorem.

SPIRAL GEARS—II

A Few Problems to Show the Use of the Formulas—Various Methods of Computing the Change Gears

BY H. B. McCABE

To make clear the manipulation of the formulas we will work out a few problems:

PROBLEM 1

Compute a pair of spiral gears to transmit the motion from the crank shaft to the half-motion shaft of a gas engine. In this case it is more convenient to make the driver the larger in diameter as the crank shaft is large, but it must turn two revolutions to one of the follower.

Suppose we are designing the engine, and can make the distance between centers to suit, but the pitch diameter of the driver should be not less than 3 inches, and on account of nearness to other parts the pitch diameter of the follower should not be greater than 2 inches. It is desired to use an 8-pitch cutter. We now have the following:

$$r_1 = 2$$
$$r_2 = 1$$
$$d_1 = 3''$$
$$d_2 = 2''$$
$$P = 8$$

First find the spiral angles by substituting in (10)

$$\cot \Theta = \frac{1 \times 2}{2 \times 3} = \frac{2}{6} = 0.3333,$$

which is the cotangent of 71 degrees, 34 minutes.

The shafts being at right angles we have

$$\Theta = 71^\circ 34'$$
$$\phi = 18^\circ 26'$$

Now substituting in (1)

$$n_1 = 3 \times 8 \times 0.316 = 7.6$$

and in (2)

$$n_2 = 2 \times 8 \times 0.948 = 15.2.$$

As it is impossible to have fractional numbers of teeth, we must change them to the nearest whole numbers that will satisfy the equation (9), and we will find that this will cause a change in the pitch diameters. Taking $N_1 = 8$, and $N_2 = 16$, and substituting in (9) we have

$$\tfrac{1}{2} = \tfrac{8}{16},$$

which is correct.

Now compute the exact pitch diameters, outside diameter leads, etc. Substitut-

(3) $$d_1 = \frac{8 \times 3.1619}{8} = 3.162''$$

(4) $$d_2 = \frac{16 \times 1.054}{8} = 1.208''$$

(11) $$D_1 = 3.162'' + \tfrac{2}{8} = 3.412''$$

(12) $$D_2 = 2.108'' + \tfrac{2}{8} = 2.358''$$

(13) $$L_1 = 3.1416 \times 3.162 \times 0.333 = 3.311''$$

(14) $$L_2 = 3.1416 \times 2.108 \times 3 = 19.869''$$

(15) $$N_1 = 8 \times 3.162^2 = 253$$

(16) $$N_2 = 16 \times 1.054^2 = 18.7.$$

By consulting the table in Brown & Sharpe's catalog, a No. 1 cutter will be required for the driver, and a No. 6 cutter for the follower.

Now computing the center distance for the shafts will complete the operations. Substituting in (5)

$$c = \frac{3.162 + 2.108}{2} = 2.635''$$

When an exact center distance for the shafts is required, having a given speed ratio, the procedure is to first decide on the most desirable pitch and spiral angles, then calculate provisional pitch diameters by (7) or (7a) and (8) and from these find the numbers of teeth by (1) and (2), which will invariably come out fractional. Change these to the nearest whole numbers having the proper ratio. This done, work back by means of (6), and note how near it brings us to the exact center distance. If too far away, other spiral angles must be chosen or "guessed at" successively, and trial calculations made with (6) until the equation is satisfied, or until the result will equal the value of c inside the limits allowable in practice. Having found the proper spiral angles the exact diameters must then be calculated by (2) and (3) to replace the provisional ones first found.

PROBLEM 2

Compute a pair of spiral gears for shafts at right angles having given:

Exact center distance of the shafts = 7 inches.

Revolutions per minute of driver = 150.

Revolutions per minute of follower = 100.

Pitch of cutter to be used, 12.

Spiral angle of driver to be near 60 degrees.

Spiral angle of follower to be near 30 degrees.

First, find provisional pitch diameters from which to determine the numbers of teeth.

Substituting in (7)

$$d_1 = \frac{2 \times 7}{\frac{150}{100} \times 0.5774 + 1} = 7.5''$$

and in (8)

$$d_2 = 14 - 7.5 = 6.5''$$

Now find the numbers of teeth by substituting in (1)

$$n_1 = 7.5 \times 12 \times 0.5 = 45,$$

and in (2)

$$n_2 = 6.5 \times 12 \times 0.866 = 67.5.$$

The nearest whole numbers which will satisfy equation (9) are

$$n_1 = 44$$
$$n_2 = 66$$

Now compute new spiral angles by using different trial values of Θ and ϕ until (6) balances, or $c = 7$ inches as nearly as possible.

Make the first trial with the provisional angles 60 degrees and 30 degrees.

Substituting in (6)

$$7 = \frac{44 \times 2 + 66 \times 1.155}{2 \times 12} = 6.85.$$

This result is too small. As the secants of a large angle increase or decrease faster for a given change in the angle than the secants of a small angle, we will make the second trial by increasing Θ.

Say, $\Theta = 62^\circ$
$\phi = 28^\circ$

substituting

$$7 = \frac{44 \times 2.13 + 66 \times 1.133}{2 \times 12} = 7.02,$$

which result is a little too large. Reducing Θ a trifle, making

$$\Theta = 61^\circ 50'$$
$$\phi = 28^\circ 10'$$

and again substituting

$$7 = \frac{44 \times 2.1185 + 66 \times 1.1343}{2 \times 12} = 7.003,$$

which is close enough for all purposes.

Now find the exact pitch diameters. Substituting in (3)

$$d_1 = \frac{44 \times 2.1185}{12} = 7.768''$$

and in (8)

$$d_2 = 14'' - 7.768'' = 6.232''.$$

Now the outside diameters, leads, etc., may be computed as in Problem 1, and as they are very plain we will not go through the operations in this and the examples following.

PROBLEM 3

Compute a pair of spiral gears, having given:

The angle of the shafts, 40 degrees.

Exact center distance of shafts, 3 inches.

Revolutions per minute of driver, 400.

Revolutions per minute of follower, 300.

Pitch of cutter, 10.

Spiral angles desired to be about 20 degrees for each gear; the spirals being the same hand.

Substituting in (7a)

$$d_1 = \frac{2 \times 3}{\frac{400}{300} \times \frac{0.9397}{0.9397} + 1} = \frac{6}{\frac{4}{3} + 1} = 2.57$$

and in (8)

$$d_2 = 6 - 2.57 = 3.43$$

Now substituting in (1)

$$n_1 = 2.57 \times 10 \times 0.94 = 24.1,$$

and in (2)

$$n_2 = 3.43 \times 10 \times 0.94 = 32.2.$$

The nearest whole numbers having the correct ratio are

$$n_1 = 24$$
$$n_2 = 32.$$

Substituting in (6)

$$3 = \frac{24 \times 1.064 + 32 \times 1.064}{2 \times 10} = 2.979$$

As a number of trials were necessary to satisfy this equation we will, to save space, present only the last one tried, in which

$$\theta = 16°$$
$$\phi = 24°,$$

when

$$3 = \frac{24 \times 1.0403 + 32 \times 1.0946}{2 \times 10} = 2.9997,$$

which is very close. Now find the exact pitch diameters as before by substituting in (3)

$$d_1 = \frac{24 \times 1\ 0403}{10} = 2\ 497''$$

and in (8)

$$d_2 = 6'' - 2\ 497'' = 3.503''.$$

Using the same conditions, if the spirals were to be the same hand and the spiral angles desired were

$$\theta = 60°$$
$$\phi = 20°,$$

their difference being equal to the angle of the shafts or 40 degrees, then substituting in (7a)

$$d_1 = \frac{2 \times 3}{\frac{400}{300} \times \frac{0.5}{0.9397} + 1} = 3\ 51''$$

and in (8a)

$$d_2 = 6'' - 3\ 51'' = 2.49''$$

Substituting in (1)

$$n_1 = 3\ 51 \times 10 \times 0\ 5 = 17\ 55,$$

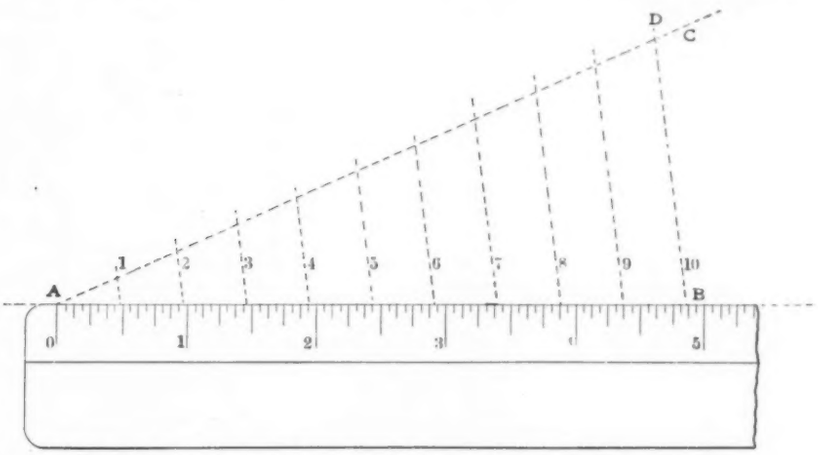


FIG. 8. GRAPHICAL METHOD OF APPROXIMATING THE VALUE OF A FRACTION

and in (2)

$$n_2 = 2.49 \times 10 \times 0\ 94 = 23.4.$$

The nearest whole numbers of teeth having the correct ratio are 18 and 24. Substituting in (6)

$$3 = \frac{18 \times 2 + 24 \times 1.064}{2 \times 10} = 3.0768.$$

By making several trials the following spiral angles were found:

$$\theta = 58° 45'$$
$$\phi = 18° 45'.$$

Again substituting we obtain

$$3 = 3.002,$$

which is quite close.

FINDING THE CHANGE GEARS

The most tedious job of all is, perhaps, finding the change gears, which will give the required lead within small limits, and allow us to use as many of the stock gears as possible. Just what variation from the true lead is allowable on good work, I have not yet determined to my satisfaction. Much must be left to judgment, perhaps. Still, it is safe to say that, if the best results are wanted, the variation must be small, and I have tried so far to keep within 1 per cent., even if a special change gear had to be made. In some cases the combinations given in the table for spirals furnished with the machine will do. Not all, however, of the combinations are given in this table. A complete table, giving all possible combinations, would be very convenient.* It is seldom a lead is required for which a combination cannot be found, in which at least two of the stock gears will not answer. The gears usually furnished are 24, 24, 28, 32, 40, 48, 56, 64, 72, 86, and 100.

In Brown & Sharpe's treatise on the milling machine is given a method of computing these gears. The worm wheel in the dividing head has 40 teeth; the pitch of the feed screw is ¼ inch. It will be found that with the machine geared to give the worm gear the same speed as the screw gear, the resulting lead will be 10 inches to one turn. Place the required lead over 10 in the form of a fraction. The lower term will be the product of the teeth in the two driving gears, and the upper term will be the product of the teeth in the followers.

In the example given the lead is to be 12 inches.

The fraction $\frac{12}{10}$ may take several different forms,

$$\frac{6 \times 2}{5 \times 2}, \frac{2 \times 6}{5 \times 2}, \frac{4 \times 3}{5 \times 2}, \frac{3 \times 4}{5 \times 2}, \frac{6 \times 2}{10 \times 1}, \text{ etc.}$$

By raising $\frac{12}{10}$ to higher terms, still more combinations may be found. Taking the first combinations,

$$\frac{6 \times 2}{5 \times 2} = \frac{6}{5} \times \frac{5}{2},$$

we have two separate fractions whose product equals $\frac{12}{10}$. Raise the terms of these fractions until they correspond to the numbers of teeth in some of the stock gears, if possible.

$$\frac{6}{5} \times \frac{2}{2} = \frac{48}{40} \times \frac{24}{24}.$$

The upper terms give the numbers of teeth in the worm gear, and second intermediate, and the lower terms give the numbers of teeth in the first intermediate and screw gear. Beginning with the worm, the gears may be in the following succession: 48, 24, 24, 40, or 48, 40, 24, 24.

Frequently, when the fraction $\frac{L}{10}$ will not work out to enable the use of stock gears, another fraction very near to it in value will. The problem then is to find one or more fractions which will differ only a little from $\frac{L}{10}$. This can be done in several ways. Brown & Sharpe, in their book on gear teeth, give a useful process by continued fractions. But it is a rather long operation, and will not give all the approximations. One way is obviously to alter the lead by increasing or decreasing it within the allowable limits, and by successive trials it may be possible to get a fraction that will give a satisfactory combination.

GRAPHICAL METHOD

A graphical method of approximating is shown in Fig. 8.

Draw a straight line and on it lay off AB equal to the required lead. Draw AC of indefinite length and making any convenient angle with AB. Beginning with A step off with dividers on AC, 10 equal spaces of any length. Join the 10th point D, to B, and draw lines parallel to DB through each of the remaining points and cutting AB in 1, 2, 3, etc. This is the familiar method of dividing a line into any number of equal parts. Apply a rule graduated in sixteenths to AB as shown. By glancing along the edge some of the lines 1, 2, 3, etc., will be found to coincide with certain lines on the rule. Fractions may now be made with the divisions on the rule as the numerators and the divisions on the line AB as the denominators. Example: Compute the change gears for a lead of 4.858 inches per turn.

$$\frac{L}{10} = \frac{4.858}{10} = \frac{4\frac{13}{16}}{10}.$$

Laying out $AB = 4\frac{13}{16}$ and dividing AB into 10 equal parts, then laying the rule on AB with the zero mark at A, we may note the following fractions:

$$\frac{8\frac{1}{16}}{5}, \frac{1\frac{13}{16}}{4}, \frac{2\frac{7}{16}}{5}, \frac{4\frac{3}{16}}{9}.$$

The vulgar fractions in the numerator may be changed to decimals quickly by the use of a table of decimal equivalents, when we have

$$\frac{0.968}{2} = \frac{968}{2000} = \frac{121}{250};$$

$$\frac{1.938}{4} = \frac{1938}{4000} = \frac{969}{2000};$$

$$\frac{2.438}{5} = \frac{2438}{5000} = \frac{1219}{2500};$$

$$\frac{4.375}{9} = \frac{4375}{9000} = \frac{35}{72}.$$

*Such a table, supplied by the Brown and Sharpe Manufacturing Company, will be found in the latest edition of "Worm and Spiral Gearing."—F. S. H.

Many more fractions may be obtained by subdividing the divisions on line *A B*. Thus: $2\frac{3}{16}$ may coincide with $4\frac{1}{2}$, when we would have

$$\frac{2\frac{3}{16}}{4\frac{1}{2}} = \frac{2\,188}{4500} = \frac{547}{1125}.$$

Of the above noted fractions one may be taken:

$$\frac{35}{72} = \frac{7}{8} \times \frac{5}{9} = \frac{35}{32} \times \frac{40}{72}.$$

All the numbers will be found to correspond to the teeth in the stock gears, and

$$\frac{35}{72} = \frac{4\,861}{10},$$

which gives the lead 4.861 inches correct within 0.003 inch.

SLIDE RULE METHOD

But the quickest way to find these approximate fractions is to use a slide rule. This may be realized by trying an example. Take the lead of the driver in Problem 1:

$$\frac{L}{10} = \frac{19\,87}{10}.$$

Setting the rule so that 19.87 on one scale is over 10 on the other and glancing along it, a number of approximate fractions may be noted at once.

Following are a few:

$$\frac{125}{63},\ \frac{139}{70},\ \frac{145}{73},\ \frac{175}{88}.$$

Of these the second and third contain prime numbers in their terms and will not be considered.

Taking the first,

$$\frac{125}{63} = \frac{25}{7} \times \frac{5}{9} = \frac{100}{28} \times \frac{40}{72}.$$

The stock gears may be used and

$$\frac{125}{63} = \frac{19\,84}{10},$$

making the lead 19.84 instead of 19.87 inches.

Taking the last fraction,

$$\frac{175}{88} = \frac{25}{11} \times \frac{7}{8} = \frac{100}{44} \times \frac{56}{64}.$$

All these numbers correspond to the stock gears except 44, and one of that number of teeth would have to be made. But

$$\frac{175}{88} = \frac{19.88}{10},$$

whence the lead will be 19.88, which is nearer to the true lead than the first calculations gave.

In computing change gears a table of prime factors of odd numbers from 1 to 1000 is very handy.

SETTING THE CUTTER

In order to cover the ground completely, one more matter should be taken up—setting the cutter central with the blank. This should be done while the table is still at the zero mark, before swinging around. This will be accurate if the axis on which the table swings cuts the axis of the main spindle and that of the dividing head, and it should do so if the machine is well made. If in doubt, a sure way is to first swing the table to the angle, then place a round blank on the centers and make a line on it with a surface gage set to the exact hight of the centers. Then with the index, revolve the head spindle a quarter turn, bringing the line on top. Adjust the table so that a slight gash made by the cutter will extend equally each side of this line, which can easily be judged by the eye.

Molding a Tank—A New Method

BY H. J. MCCASLIN

There is certainly no other department connected with a machine-manufacturing establishment that affords such a variety of ways or methods of producing practically the same results as the foundry. Fig. 1 shows in plan and elevation a filtering or strainer tank of cylindrical form. By observing its general outline and distribution of metal, it will be readily seen that the casting could be produced in several other ways than that to be shown. Drawing a pulley ring to any width, which is the principal feature of this method, is old, and no claim is made for originality, except its application to this particular case.

PREPARING THE BED

In beginning the work a level bed is struck off and a stake containing the dowel pin *C*, Fig. 2, is firmly driven at the center to which is atached the sweep *B*, the striking edge of which contains the form of the under side of the feet. By revolving the sweep around the stake a bed is struck off as shown. The dowel pin *C* is then removed from the top of the stake, and right-angle lines are drawn through this center across the bed to locate the four cores *D*, which are made in halves and pasted together, and contain the impressions of the feet. They are placed in their correct positions against the swept surface of the bed. To prevent the weight of the cast-iron ring pattern from resting entirely upon the foot cores *D*, four pieces of bar or rod iron are driven in the bed as shown at *E*, and about half way between the cores.

The sweep stake is now removed and in its place is firmly driven a long stake as shown in dotted lines, and extending up to the level of the intended under side of

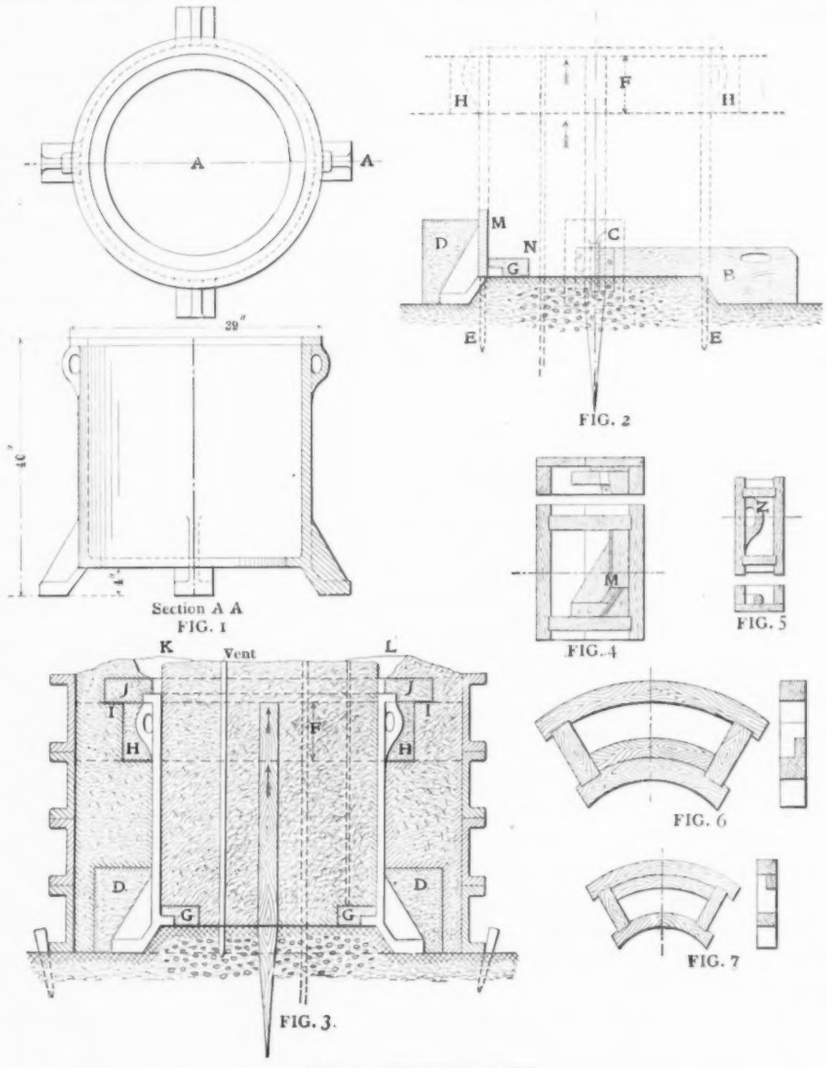


FIG. 3. MOLDING A TANK

top flange of casting. The distance *F* down from the top of the stake to the underside of the cores *H* for the lifting ears, is scribed around the stake as a guide when drawing the ring to this hight, and for striking off a bed to receive these cores, as shown in dotted lines. A cast-iron ring *M* of the required inside and outside diameter and having a face of about 8 inches is next placed in position and supported by the rods *E* and cores *D* and tried with the spirit level.

RAMMING AND DRAWING THE RING

A number of pieces of 1-inch guide pins about 16 inches long are then driven down into the bed at different points around the inside of the ring. With the first section of the flask staked down as shown in Fig. 3 the operation of ramming is in order. The outside is proceeded with first to a hight of two or three inches above the lower edge of the ring, care being taken that the ring is not rammed out of place. Any sand that may have rammed under the ring and into the inside is removed, and the cores *G*, which form the internal flange at the bottom, are set in position, and rods *N* are driven in the bed back of them. The inside and outside are rammed up to the hight of 5 or 6 inches, the vent rod being freely used, the ring and guide pins are drawn up several inches, and the operation of ramming and venting is repeated, with the green-sand core well rodded. The spirit level should be used on the upper edge of the ring during each drawing, to insure a straight and even casting. The process of ramming and drawing the ring and guide pins is continued until the top of the ring comes in line with the gage line on the stake, representing the underside of the ear cores *H*. At this point when the outside has been rammed up, a level bed is struck off at the top of the ring, as shown in dotted lines, after which the ring is drawn up in line with the top of the stake. The ear cores *H* are then set in position against the ring and diametrically opposite each other. Ramming, venting and rodding are continued to the top of the ring and cores *H*, at which point a bed is struck off to receive the flange core *J*, Fig. 3. The ring and guide pins are drawn up several inches above the top section of the flask, the inside is rammed up as shown, and the ring and guide pins are removed. Provision having been made for the gate *K* and riser *L* in two of the flange cores *J* they are set in place and backed up with sand to the top of flask, as shown in Fig. 3. With the pouring basin and riser arranged the mold is ready to be poured.

THE CORE BOXES

The core boxes for forming the four different cores are shown in Figs. 4, 5, 6 and 7. Fig. 4 shows the box used in forming one half the foot core, an opposite hand piece *M* being required in the box to form the other half of core. Fig. 5 shows the box for forming one half the lifting ear core, which also requires an opposite hand piece *N* for the other half. Figs 6 and 7 show the frames employed in forming the upper flange core *J* and the lower internal flange core *G*. The ring casting was rammed up with the aid of a segment attached to a stake, and subsequently turned to dimensions.

Hours of Labor and Wages in Various Trades in the United States

From the report of Government representatives investigating leading lines of business activity in this country it seems that as compared with returns for 1904 there has been an increase in the wages paid agricultural-implement workers of 1.6 per cent. per hour, with a decrease of 0.2 per cent. in the number of hours making a week's work. Steam-railroad car builders show a decrease in wages of 1.1 per cent. and in time of 0.6 per cent.; on the other hand, foundry and machine shops show an increase in hourly wages of 0.1 per cent. and in hours of work of 0.2 per cent. In the manufacture of bar iron there has been an increase of 1 per cent. and in hours of 0.2 per cent.; in bessemer converting of 7.5 and 0.1 per cent.; and in blast-furnace work of 2.7 and 1 per cent. respectively.

To secure this information visits were made to 4121 establishments and 349 different occupations covered. In the total number there was an increase in the total number of persons employed from 295,087 in 1904 to 314,009 in 1905.

Under the general industry of agricultural implements, 8 occupations and 23 establishments are included and the number of employees in these was increased from 5809 to 6673. The general classification of foundry and machine shops covers 10 occupations and 268 establishments; in these it was found that there had been an increase in the number of employees from 22,193 to 24,798.

The iron and steel industry shows 6 occupations under bar iron, includes 25 establishments visited and an increase from 880 to 914 employees. Bessemer converting also covers 6 occupations and 16 establishments, and a slight increase in the number of employees from 287 to 291. Blast furnaces show 5 occupations; 23 establishments were visited and showed an increase in employees from 920 to 955. The building of steam-railroad cars covers 17 separate occupations. Forty-six establishments were visited and showed that there had been an increase from 27,256 employees in 1904 to 32,083 in 1905.

Going further into detail, the occupations included under agricultural implements are: Blacksmiths, the number of whom increased from 542 to 621, average wages per hour from .268c. to .2766c.; fitters, 729 to 781, wages from .2343c. to .2472c.; grinders, 423 to 472, wages from .2779c. to .2817c.; machine woodworkers, 463 to 577, wages from .2239c. to 2309c.; machinists, 1347 to 1545, wages from .2565c. to 2553c., a slight decrease; molders, 1561 to 1840, wages decrease from .2576c. to .2490c.; painters, 637 to 724, wages from .2415c.; to .2472c.; patternmakers, 107 to 113, and wages from .2869c. to .2871c. per hour.

In the general industry of manufacturing steam-railroad cars there are included, as already stated, 17 separate occupations, and it appears that the bulk of this work is done in the Northern Central States. Included in these 17 occupations are blacksmiths, and the number of men employed in this line of work during the past year increased from 1239 to 1333. The average number of hours' work per week has been slightly reduced, also the average hourly wage, from .3131c. to .3028c. Thirty-three establishments engaged in boiler making show an increase in employees from 985 in 1904 to 1044 in 1905. Here the average number of hours per week has been reduced from 56.67 to 56.02, while the average wage has increased from .3145c. to .3210c. per hour. The next occupation is that of brass finishing. In eight establishments, the number of persons employed in 1904 was 161; in 1905, 182. The average number of hours fell from 54.61 to 54.30 and the hourly wage from .3312c. to 2883c. The number of machinists employed in 45 establishments has increased from 4581 to 5207, hours have slightly decreased and wages increased. The only branches of this great industry showing decreases in number of employees are iron molders, from 458 to 451, tinsmiths from 676 to 619, and upholsterers 460 to 376. On the other hand, brass molders increased 102 to 108; painters from 1696 to 1853, patternmakers 173 to 185; pipe fitters from 555 to 634.

Under foundry and machine shops are included ten different occupations: Blacksmiths, 179 establishments; boiler makers, 91; boiler riveters, 20; brass finishers, 26; core makers, 119 male and 5 female; laborers, 192; machinists, 206; molders, brass, 48, iron, 169; and patternmakers, 171. Of these, only the brass molders show a decrease in number of employees, from 310 to 292. A slight increase in the average number of hours of employment is shown in the cases of brass finishers, male core makers, laborers, machinists, molders, and patternmakers. Only laborers, machinists and patternmakers show any increase in wages.

The brass catches and clasps used on toy bracelets and necklaces have been decided to be subject to a duty of 45 per cent. as manufactures of metal. They have been taxed as jewelry at 60 per cent.

THE MAKING OF A DRILL CHUCK

Aims and Methods of Its Inventor—Reorganizing the Business to Meet Demands

The Almond drill chuck was invented by the late T. R. Almond. Like everything he put his hand to, it is as near perfection as he knew how to make it.

A peculiar man, as measured by the standards of most men, he had no desire to have a business so large that he would be obliged to have assistance in managing it. Thus in the matter of mere volume of business he was easily gratified; but when it came to a question of excellence in the product, he was most difficult to satisfy.

An exceptionally skilful mechanic himself, he could not countenance poor workmanship from those he employed. The work was either right or wrong; there was no middle course, no "touch it up a bit and let it go." A part was either fit to be incorporated in a chuck or in the scrap pile.

In this way he built up an enviable reputation for the quality of his product.

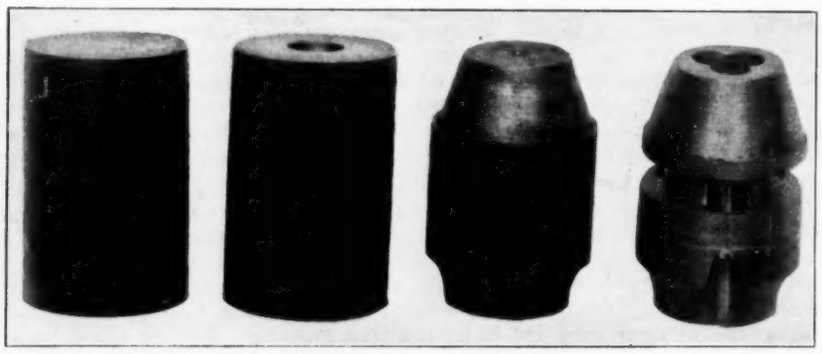


FIG. 1. THE OPERATIONS ON THE BODY

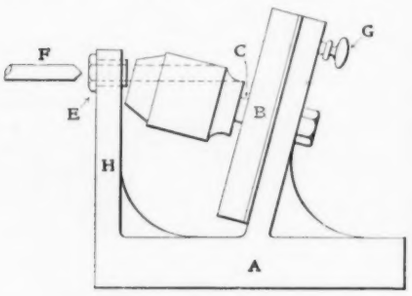


FIG. 2. DRILLING THE JAW HOLES

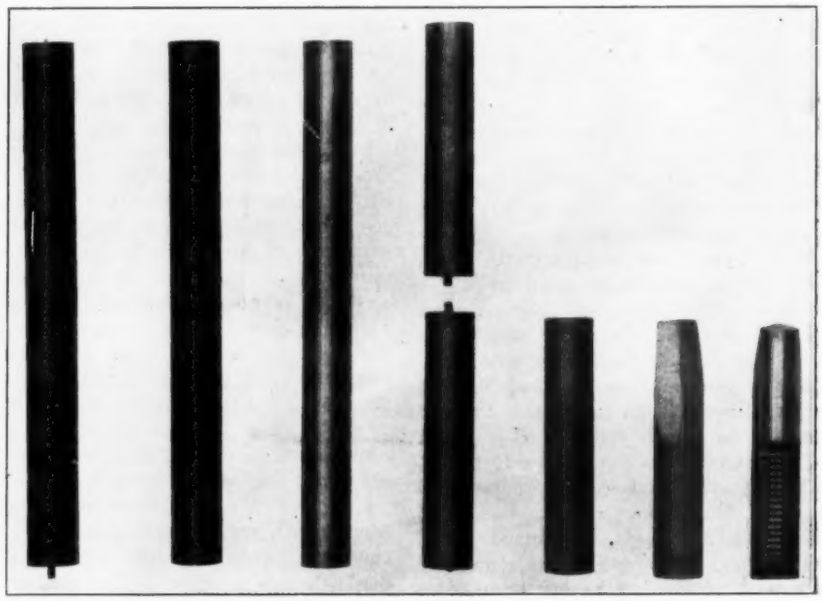


FIG. 3. THE OPERATIONS ON THE JAW

For two years prior to and since Mr. Almond's death last March, the business has been carried on by C. A. Hubbell, a life-long friend of Mr. Almond. While speaking of the future of the business the other day, Mr. Hubbell said:

"The chuck will still be manufactured in the 'Almond way,' as far as accuracy of workmanship and high quality of material are concerned; but I am going to make an effort to turn out all the Almond chucks the trade demands. There has never been a time for years that the business has kept pace with the orders."

With this end in view, special machines have been ordered to lessen the number of operations, but with the distinct understanding that accuracy must be maintained. Otherwise the special tools will not be retained.

The samples of the various operations now before me were made by the old methods, as the special machines have not yet been set up.

The operations here described, and the illustrations shown, cover the manufacture of the No. 3 Almond drill chuck with a capacity from 0 to ½ inch. In the manufacture of the smaller chucks there are some slight deviations from these operations; but they are so slight as to be scarcely worth mention.

THE BODY

In Fig. 1 the body is shown in various stages of development, beginning at the left, where the 2-inch bar of machinery steel is shown cut into a 3-inch length. The blank is faced to a standard length, the arbor hole is then drilled and reamed with a taper reamer. It is then mounted on a true arbor, and the opposite end is accurately centered. The next sample shows the body in this state. All subsequent operations on the body are performed with the tapered arbor hole as a starting point.

The next operation is rough shaping the front and back ends of the body. This is done on a lathe, the body being driven on a taper mandrel held in the live spindle; the body is supported at its outer end by the tail center.

The body then goes to a special machine where the jaw holes are drilled and reamed.

The jig used in drilling the jaw holes is shown in Fig. 2. *A* is the body of the jig which slides on the ways of a lathe. *B* is a plate carrying the arbor *C* on which the chuck body *D* is driven. *B* indexes to three positions for the three jaw holes, and is locked by the pin *G*. The guide *H* swings transversely (not shown), it carries several bushings which guide the various drills and rose bits. These can be swung into position and locked, or swung entirely out of the way to put the chuck body on the arbor or remove it therefrom.

The body is mounted on the taper arbor *C*, and twist drill *F* is passed through it; *B* is then rotated 120 degrees, and the other two holes drilled in succession. A rose bit then replaces the twist drill, and

the three holes are enlarged with it. This is followed by another rose bit, which is still larger, which in turn is succeeded by a machine reamer. The body is then removed from the arbor, and a hand reamer with a long pilot is passed through the holes.

After hand reaming the body is put on an arbor in the lathe, rough grooved for the nut, and rough turned on its large diameter. It is then ready to finish the grooving for the nut and the second turning on the body. The sample to the right in Fig. 1 shows the body in this condition. The front end at the center of the jaw holes is then drilled so that drills, etc., can enter the jaws of the finished chuck to a sufficient depth.

THE JAWS

Fig. 3, in the same order as Fig. 1, i.e., from left to right, shows the jaws in various stages. The stock used for the jaws is ½-inch Jessop tool steel; this is cut in 5-inch lengths, sufficient to make two jaws. After cutting off they are centered on the ends turned, and cut in two. The burs are ground off and the pieces are numbered 1, 2, 3, according to the position they are to occupy in the asembled chuck. The grip is then milled.

FIG. 4. THE NUT

The thread used in these chucks is a modified buttress thread. To produce this thread a special machine is used, in which the jaws are located by the grip, i.e., the part that grips the drill in the finished chuck. This part in each jaw bears a constant relation to the nut, which actuates it, and to the other jaws; therefore, using the grip as a starting point, the chances of making a misfit are very slight.

I have so far not mentioned anything about gages. Every operation has its set of gages and every tenth piece is compared with them, a duplicate set of which is kept in the office.

After the threads are milled the sharp corners, where the curve of the threads meets the round of the jaw, are relieved with a file so as to obviate any chance of the jaw scratching the hole should the friction of the nut in use throw a bur up on the edges of the threads.

The grip end of the jaw is next centered with two small centers in a special fixture; these are used in drivng the jaw when being ground after hardening.

The jaws are now hardened. They are heated in a gas furnace, and dipped to the depth of the first thread behind the grip and left dead hard.

Mr. Hubbell is an authority on steel and tempering, having been superintendent of the Simonds Manufacturing Company for a number of years; consequently he is very particular about the hardening methods. After hardening, the jaws are ground to size and polished. By the hardening methods used the steel is merely discolored, there being no scale raised on it.

THE NUTS

The nuts shown in the two stages at Fig. 4 are at present made from drop forgings; later it is intended to make them from bar stock. The material used is the same as that for the jaws, Jessop tool steel.

The nuts are first rough turned and then threaded. For threading, a sliding chaser is used, which won my admiration the moment I saw it, as it could be used for a number of taper-threading jobs which now have to be done with taps on a taper attachment.

Fig. 5 shows the threading device. *A* is a steel head fitting the tail spindle *D*, and having a formed slot in it to accommodate the sliding chaser *B*. *C* is the nut. Before threading, the chaser *B* is slid out of the slot, and a similar-shaped cutter, but having no teeth, is used to size the tapered hole in *C*. After it is true the chaser *B* is put in place, and a piece of rectangular tool steel is secured in the tool post of the lathe. This is brought to bear against the rear end of the chaser *B*. The pitch of the threads in the nut is 16 to the inch measured on the angle. Therefore special gears are used to feed the carriage along the ways so as to feed the chaser in at an angle at the correct rate. The chaser *B* is thus fed into the nut until sufficient threads are formed to draw *B* in without further use of the feed. The carriage feed is then thrown out and the thread in the nut draws the chaser *B* till the toothed part is completely through the nut. The tailstock is then drawn back together with *A* and *B*. This device makes a good thread and very quickly.

The nuts are then faced on the end and the first thread on each end is chamfered off. It is then removed from the chuck, and the burs are scraped off. The nut is next put on a threaded mandrel and faced to thickness, turned to finished diameter,

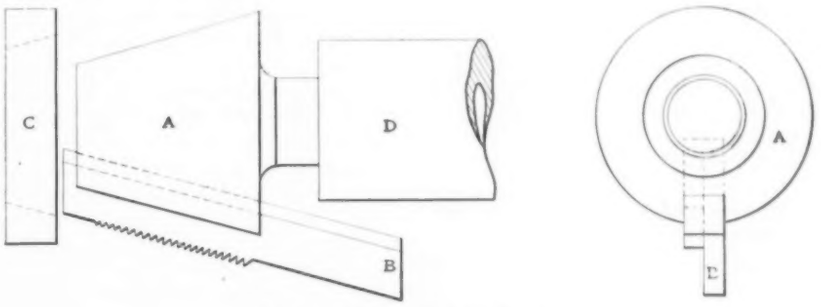


FIG. 5. THREADING THE NUTS

and the corners are rounded off. After taking off the mandrel it is nicked with a file, as shown to the left in Fig. 4, and hardened.

The two small filed nicks are to facilitate breaking the nuts at the desired point. They are laid on a piece of iron shaped concave for the purpose and a sharp tap with a hammer breaks them as shown to the right in Fig. 4. The temper is then drawn by a special process which prevents their losing their shape and size. In this way the position of the thread relative to the faces of the nut is retained, which would not be the case were the nuts distorted in the hardening sufficiently to require grinding on their faces so as to enter the groove in the chuck body.

It is obvious that if the nuts were thus distorted and their faces ground the threads would be drunk and the advance of the jaws intermittent and while the grips might at times be concentric with the chuck body they would not be so at all points and drills held in them at these points would not run true.

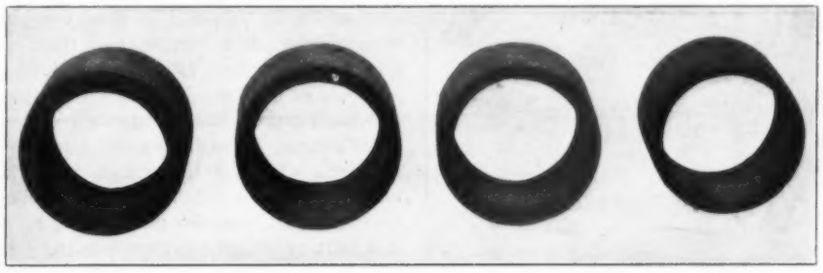


FIG. 6. THE OPERATIONS ON THE FERRULE

THE FERRULE

Fig. 6 shows the ferrule in four stages. To the left is shown the steel tubing from which the ferrule is made. It is cut to

this length from long bars. These pieces are gripped in a chuck, bored and machine reamed. The reamer used has about 6 degrees taper. With the taper fit, the ferrule may be forced on the nut a little farther should wear occur; it is easily removed and centers itself on the tapered outside of the nut. After machine reaming the ferrule is hand reamed, driven on a mandrel, turned to size and nurled. The peening effect of the nurling alters the size and shape slightly so the ferrules are again hand reamed, after which they are faced and the spanner holes are drilled.

It must of course be understood that these chucks are made in large lots which pass through the various operations in large lots.

ASSEMBLING

The assembling operations are fourteen in number. The ferrule is driven on the taper body of the chuck and the two are driven on an arbor in the lathe. The tapered front and curved back ends of the body are then finished. This of course finishes the ends of the ferrule as well. The body and ferrule ends are then polished and the ferrule is taken off while a light cut is run over the large diameter of the body so that the ferrule will grip the nut and clear the body when the chuck is assembled. The body is then removed from the arbor and the finishing reamer is put through the jaw holes. This reamer is only 0.00025 inch larger than the previous reamer. It was found that if any more than 0.00025 inch were left for the finishing reamer to remove the holes would not be uniform in size. This

FIG. 7. THE COMPONENT PARTS OF THE CHUCK

reamer is made with a long pilot the size of the holes, so as to steady it in its passage through the body.

The burs on the ends of the jaw holes, etc., are then scraped away by hand and the jaw holes are numbered 1, 2, 3. The chuck is then assembled, but as the work is so snug, a little easing is necessary in places. This is done with flour emery and oil, the chuck being mounted on an arbor and the nut run back and forth. The front ends of the jaws and body are ground and polished and the chuck is taken apart and washed to remove all traces of emery.

The chuck is reassembled and the back end of the body is faced to remove any slight bruises which may have been made in it during the numerous handlings through which it has previously gone. It is then stamped with the name, after which the back end is polished. The arbor hole is then re-reamed for the last time to remove any burs or bruises. The chuck is now mounted on an absolutely true arbor, while an internal-grinding fixture grinds the grip of the jaws parallel to and true with the arbor hole. The chucks are again polished and then the jaws are run in and out on a special machine, with plenty of oil to work out any slight stiffness. This finishes the chuck, which is then ready for final inspection and packing.

The component parts of the finished chuck are shown at Fig. 7. These parts have taken 83 operations to finish; 12 operations for each of the three jaws, 36 in all; 13 for the body; 11 for the nut; 9 for the ferrule; and 14 assembling operations.

Mr. Hubbell, who accompanied me through the works, was not yet satisfied that I knew how well the chucks were made; so when we got back to the office he proceeded to prove this to me in a rather novel way.

He said he had always impressed upon his workmen the necessity of doing the work the best they knew how, so that no matter what test the goods were put to, they would show their high quality. It had been his custom for years, in connection with the Simonds Manufacturing Company's product, if a discussion arose regarding the comparative merits of his goods and those of a competing concern to settle it by buying a sample of each at a local hardware store and testing them out by breaking or any other means. In such tests the workmanship was of equal importance with the material, and as the material furnished for each part was the most suitable for that part (all steel being ordered to conform to a specification giving its chemical and physical properties), any defects in hardening would be readily discoverable.

Mr. Hubbell then took an Almond chuck nut and one of another make into the shop where he asked me to break them. I secured half the Almond nut in a vise and struck it several blows with a hammer, but was unable to break it till I had ground a nick on both sides. The half nut of the other make was then put in the vise, and broke easily without being nicked. The two fractures are shown at Fig. 8. The fracture of the Almond nut to the right shows the fine crystalline fracture of good tool steel properly tempered. The other shows a fine crystalline structure around the edges to a depth of about 1/64 inch, but inside of that the crystals are coarse, having the appearance of steel that has been overheated in harden-

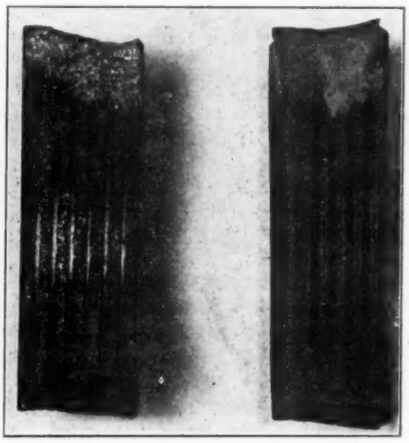


FIG. 8. THE BROKEN NUTS

ing. The steel used in the Almond nut is the best quality of Jessop tool steel, while in the other a cheap grade of machinery steel case hardened has been used. I tried this same breaking test on other pieces with the same results.

Before closing I want to thank the superintendent, Mr. Remington, for the pains he took to explain the many things I did not grasp as quickly as I perhaps ought to have done. E. A. S.

Demand for Copper Increasing

The price of copper recently attained the highest position since the Secretan corner in 1888. This is due to the extraordinary use of the metal for electrical purposes. Efforts to find a substitute for copper in electrical work have met with little success. Aluminum is the only similar medium thus far discovered, but its price and output threaten no competition with copper.

The world's production is now stated to be 700,000 tons. The production in 1905 was 100,000 tons greater than the average for the last five years, while the latest quotation of about $418.51 per ton compared with the average of $301.72 for the last five years. Despite these almost sensational figures there are no excessive stocks in any position.

The output in the United States for 1905 was 397,909 tons. Spain and Portugal produced 48,000 tons and Mexico 60,000 tons; but there was an actual decrease in production by Spain and Portugal as compared with 1904, while the Mexican production has more than doubled since 1900. It is stated that 876,000 tons of copper will be necessary to meet the demand for the metal by 1910.

The Microstructure and Frictional Characteristic in Bearings Metals—I

BY MELVIN PRICE

The investigation here recorded was carried out in the laboratories of the department of Mechanical Engineering and the department of Metallurgy at Columbia University. The main questions considered were: (1) The law of variation of the amount of friction with the velocity of sliding, other conditions remaining constant. (2) The theory of Charpy and others regarding the function of the hard grains and of the plastic ground mass in the microstructure of alloys. (3) The theory of Professor Goodman, which received the credence of Prof. W. C. Roberts-Austen, the eminent metallurgist, which theory related to the effect produced by elements of high atomic volume as distinguished from the effect of those of low atomic volume in bearing alloys.

Regarding the first of these questions, in the earlier years of the last century, Morin made many observations which he interpreted to mean that the force of friction is independent of velocity. Many later investigators have made determinations which they interpret to mean that Morin's conclusion could not have been correct, and some have attempted to replace Morin's law of independence of velocity by a law in which the whole range of ordinary working speeds is divided into three or more gradations, each of which has a separate characteristic regarding speed-friction variation.

The theory of Charpy evolved through an investigation of the metallurgy of a number of alloys belonging to the types commonly noticed in use in machine practice for bearings was that the friction of hard substances was less than that of soft ones, and that, therefore, the hard grains in alloys supported the load and contributed to the alloy whatever anti-friction quality it possessed, while the plastic ground mass in which the hard crystals were embedded served to allow the bearing step to mould itself around the shaft, producing a better fit. It is clear from his account that his conclusion is not based upon frictional tests. He attempted to differentiate between the metals from this standpoint by using the apparatus devised by Le Chatelier. But after many trials they concluded that with the apparatus at hand absolutely no difference could be detected between the resistances of alloys when lubricated, even when such alloys differed widely as to physical properties and microstructure, and that there was no certain difference when run in the dry state. Charpy then proceeded to examine a number of industrial bearing alloys from a metallurgical standpoint, supplementing the investigation by a number of compressive tests. The impression left with the reader of his paper is that he believed himself able to justify the use of these industrial alloys (which had been empirically developed) by assuming that the hard isolated crystals of chemically combined metals found in the microstructure, were the factors essential for the support of the load, and that being hard substances their friction was less than that of the soft matrix, the plastic property of which matrix as exhibited in his compressive tests completed the justification for the use of such alloys.

Goodman's announcement was to the effect that whenever a bearing alloy supposed nominally to contain the ordinary *pure* metals commonly used for such purposes had added to it a third constituent, the friction was raised or lowered in value according as the added constituent was of low or high atomic volume. In a discussion at a meeting of the Institution of Mechanical Engineers, April, 1895, Professor Goodman is quoted as having early noticed great differences in the resistance of alloys which in tentative analyses had shown practically identical compositions. Further and more complete analyses, however, showed minute quantities of impurities. Going deeper it was found that when these impurities were elements of low atomic volume the resistance was increased, but when of high atomic volume the reverse kind of performance was observed. After much experimenting, he generalized by establishing as a "law" that a good bearing metal must have at least one constituent of high atomic volume, or in words, regarding his investigation, "it showed indeed clearly the importance of getting absolute purity in metals used for anti-friction alloys, that is purity at least in the sense of keeping out metals of small atomic volume."

Laws of friction.—The laws of friction as announced by Morin were as follows:

(1) The friction between two bodies is directly proportioned to the pressure, *i.e.*, the coefficient is constant for all pressures.

(2) The coefficient and amount of friction, pressure being the same, is independent of the areas in contact.

(3) The coefficient of friction is independent of velocity, although static friction (friction of rest) is greater than friction of motion.

In direct contrast with the above, we find the modern beliefs regarding frictional behavior stated by Mr. John Goodman in a review of the results obtained from the testing machines of Thurston, Tower, and Stroudley, as follows:

(1) The coefficient of friction for moderate pressures and speeds varies approximately inversely, as the normal pressure.

(2) The frictional resistance varies as the area in contact, the normal pressure remaining constant.

(3) At very low journal speeds the coefficient of friction is abnormally high; but as the speed of sliding increases from about 10 to 100 ft. per min. the friction diminishes, and again rises when that speed is exceeded, varying approximately as the square root of the speed.

In support of the former laws, deduced by M. Morin, there is the work of Coulomb and that of Rennie, and of others less notable. Morin's work itself is so extensive as to be pretty convincing, his three *Memoires* containing no less than 178 series of not a few cases each, the experiments having been performed under varying conditions of material, area of contact, pressure, velocity, rest, retarded movement, accelerated movement, uniform movement, lubrication, etc. The apparatus by means of which Morin's laws were obtained consisted essentially of a *traineau*, or sled, whose performance upon a rectilinear track was studied.

Latterly we have seen for the friction test various contrivances, nearly all of which differ radically from the ingenious mode of Morin. Rotative devices are now the most commonly used. In these the moment of the friction is usually measured directly. By means of a rather good machine of the latter type Mr. Beauchamp Tower has given to us the results which perhaps form the best basis for a law of friction of which we now have knowledge. These seem to establish a relation between the force of friction and the area in contact. The following figures, due to John Goodman, from Tower's results, were taken from Kent's Pocket-book:

Load in pounds per sq. in.....	529	468	415	310	258	205	153	100
Frictional resistance per sq. in..	.416	.498	.472.	464	.438	.43	.458	.45

Thus if we let

A = area in contact.
P = total normal pressure.
F = total resistance to sliding.
p = normal stress.
$\frac{F}{A}$ = constant, although p is a variable.

Recognizing the obvious fact that no two surfaces when placed into contact can be conceived to fit exactly except in case the normal pressure is made great enough to overcome the tendency toward *point*, or small area contact, and calling the total area of the smaller surface the apparent area, and the summation of all small areas actually touching the real area, we may adopt the following further symbols:

A = apparent area in contact.
A' = real area in contact.
p = apparent stress over area.
p' = real stress over area.
μ = coefficient of friction.

Now suppose a uniformly distributed load be applied to the upper body: then probably the elastic material of this body will deflect so as to place greater area into coincidence. A question which cannot be

* Presented at the Scranton meeting of the American Society of Mechanical Engineers.

answered with certainty because of incomplete knowledge of initial internal stresses, unequal rigidities, etc., is as to *how the real area of contact varies with the total pressure on a body.* But, making the simplest assumption consistent with facts, let us say that A' varies directly as P. Now $p' A' = P$, so that the above assumption leads to making p', the mean stress over the actual tangent area, a constant quantity. From the fundamental definition we have, $F = \mu P$, and dividing A' we get

$$\frac{F}{A'} = \mu \frac{P}{A'} = \mu p'.$$

in which p' is a constant quantity by our hypothesis.

It is probably quite reasonable to assume that in the experiments of Tower the real areas were very closely equal to the apparent ones, since the above quoted results agree very well and, in fact, everywhere his work is consistent. But he obtained $\frac{F}{A} =$ a constant. If A in his case he put $= A'$, then his results may be applied to our present question, and we may put $\frac{F}{A'} =$ constant. So that if we keep increasing the normal pressure P from a small value upward, A' will increase proportionally, by hypothesis, until it approaches very nearly the apparent area A. But below the latter critical value we have $p' =$ constant, and $A' =$ constant, the former by hypothesis and the latter by Tower. In the expression

$$\frac{F}{A'} \mu p'$$

we must then have

$$\mu = \text{constant}$$

up to the critical point where $A' = A$, although we have been *varying* the applied pressure P. If $\mu =$ constant within this range, remembering that $F = \mu P$ we have the *friction varying directly as the pressure* P within the range of varying contact, provided Tower's conclusions are correct in experiments conceived to have been carried out wholly above and outside that range. If $p = \frac{P}{A} =$ the apparent stress it is seen, since $P = pA = p'A'$, A' is always less than A, and consequently p' always greater than p except at and above the critical point where $A' = A$ and $p' = p$.

It is thus seen that there may be a well-defined condition where the force of friction varies directly as the total pressure; with a constant apparent area, directly also as the apparent stress. But this is the first law of Morin.

The latter's law regarding contact areas is more difficult to account for. If, for instance, we could write, when the apparent surface was arbitrarily varied,

$$A' = K_1 A$$

where $K_1 =$ a constant. Then still adher-

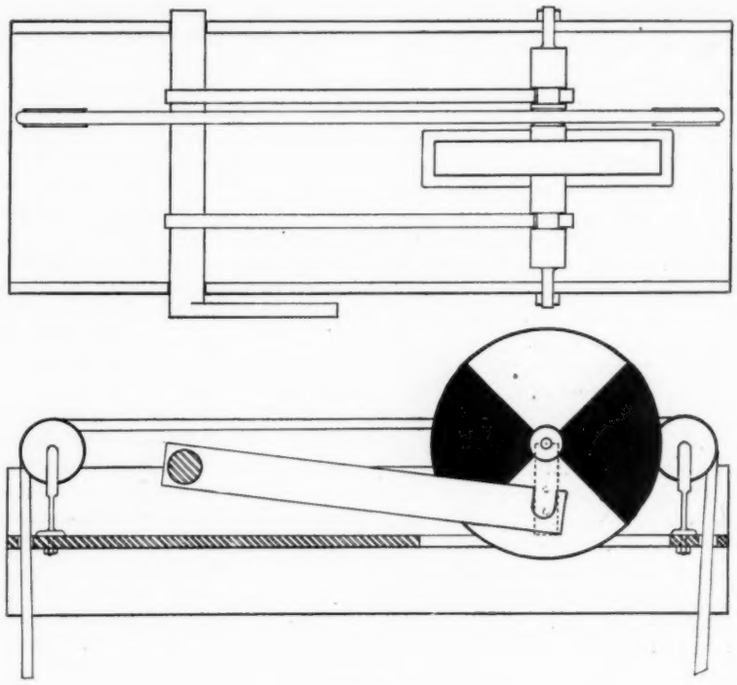


FIG. 1

N.	14	13	12	11	10	9	8	7	6	5	4	3	2	1	
						6	6	6	6	5	7	6	7	7	W
			8	7	8	8	7.5	8	7.5	8	8	8	9	8	W
								7	7.5	7.5	8	7	7.5	6.5	W
					7	8	9	9	8	9	8.5	8	8.5	7	W
					7.5	8.5	8	8.5	7.5	8.5	8.5	8.5	8.5	7.5	W
							8	7	7	8	8	9	8	8	W
		8	8	8.5	8.5	8.5	8.5	9	9	9.5	6	13.5	9	8	U
							10.5	10.5	9.5	10	10	10	9.5	8	W
					9	8.5	8.5	9	9	9.5	9	9.5	10	9	U
						10	9.5	9.5	10	9.5	10	10	10	8	W
		9	8.5	8.5	8.5	8.5	8.5	8.5	9	9	9	10	8	7	U
				9	9	8	8	8.5	9.5	9.5	9	9.5	9.5	8.5	W
							8.5	8	8.5	9.5	10	10	10.5	9.5	U
			8	8	8	8.5	7.5	8.5	8	9	9.5	9	9.5	7	U
					11	10	11	10	9	9.5	10	10	10	8	W
				8	8	8.5	7.5	8	8	8	10	9.5	10.5	8	U
				8	8	8	9.5	8.5	10	10	10	11	11.5	9.5	W
			10.5	9.5	9	9.5	9.5	11	11	12	14	14	13	9	U
						10	10	10	10	10	10	13	13	9	
				9	10	9	9	11	10	11	10	12	12	10	W
					12	11	11	10.5	9.5	10	12	12	13	9	U
					10	11	11	11	10.5	10.5	10.5	12.5	12	9.5	
					7	9	9	9	10.5	11.5	11	13	10	9	W
						9.5	9.5	10	12.5	11.5	11	13	9	8	U
						8	6	7	8	8	8.5	8.5	10.5	7.5	
					10	14	17	9	13	15	14	12	11	9	W
								15	14	14	14	14	13	9	U
					10	12	12	12	14	15	14	15	13	9	
						14	13.5	13.5	14	15.5	16	14.5	13.5	10	W
						12	11	12	14	13	13	13	12	10	U
							10	10	11	13	13	13	11	10.5	
							12	13	13	15	15	14	13	10	W
							11	11	13	11	15	16	13	12	U
								12	11	14	12	13	12	12	
				7	8	8	7	8	9	9	9	8	9	6	W
				9	9.5	9.5	9.5	10.5	11	11	10	9.5	8.5	6	U
		8.5	8	9	9	7.5	7	7	9	8.5	7	7	7	7	
			9	8	8	9	9	9	9.5	9.5	9	10	9	6.5	W
			9.5	9.5	8.5	8.5	7.5	8	9	10	10	10	9	8	U
			7	6	7	7	7.5	8.5	8.5	8.5	9.5	10	9.5	6	
				9	9	9.5	9.5	10.5	9.5	10	9.5	10.5	9	7	W
	9	10	9.5	10	9.5	10	10.5	10.5	10.5	10.5	10	10.5	10.5	7.5	U
			6	6	6	6	6	6.5	7	6.5	7	7	6	7.5	
	8	9	9.5	10.5	8	9	9	8	7.5	8.5	8	9	8	7.5	W
		8	7.5	7.5	7	6	7	8	10	11	11.5	10.5	10	7	U
			7	7	6.5	7	7	8	7.5	8	8	8	8	7	
					13	13.5	12.5	13.5	13.5	14	14	14	13	12	W
	11.5	12.5	12	13	13.5	14.5	15	16.5	16.5	17	17	15	15	13	U
		10	8	8	9	9	9	9	9	9	10	11	12	11	
		12	11	14	15	15	16.5	16.5	19	19	17	18	18	13	W
	10	11	10	11	9	11	12	13	14	16	16.5	18.5	17	13	U
							14	17	16	16	17	17	16	11	W
	10	11	10	11	10	10	11	11	13	15	16	17.5	17.5	12	U
		10	9	10	10	20		12	13	16	17	11	19	13	W
		7	8	10	8	9	8	10	9	9	10	10	10	10	U
12	10	9	8	8	10	12	9	10	10.5	10.5	11	15	13	13	W
		8.5	8.5	9	9	10	9	9	8	9	17	19	18	11	U
		9	9.5	11.5	10	10	9	11	11	12.5	15	18.5	19	13	W
		12	14	13.5	12.5	12	11	14	14	16	21	30	17	15	U
	11	13	11	12	11	12.5	13	13.5	14	14	16.5	18.5	18	15	W
11	11	11	11	13	13	13	13.5	15.5	16	20	21	23	21	15	U
			13	11	11	12	13	15	16	17	20	21.5	20.5	14	W
	12	14	11	11	11.5	14.5	15	17	20	21	23	29	19	16	U
		9.5	10	12	12	12	13	13	15	17	21.5	18	17	15	W
	12	12	11	12	13	14.5	16	17.5	21	25	27	28	28.5	18.5	U
10	11	11	10	10	11	14.5	16	16	18	21	23.5	27.5	31	21	W

ing to $\frac{F}{A'}$ = a constant, and reckoning that P = a constant, we should have

$$F = \mu P,$$

$$\frac{F}{A'} = \frac{\mu P}{A'} = \text{constant} = K_2,$$

$$\mu = \frac{K^2 A'}{P} = \frac{K^1 K_2 A'}{P} = K_3 A$$

or μ varies as the apparent area of contact surface where Morin often repeated "*Indepedant de etendue de la surface de contact.*" But we must remember that we are still under the hypothesis applying to low pressures, below the critical point, at which real contact area becomes equal to apparent contact area, and that under such conditions the contact is very likely to be that of points rather than areas. Now since three points of such contact may stably support a body on a surface, it is in such cases extremely unlikely that $A' = KA$, as it was above assumed. Rather it is probable, when the apparent surface was arbitrarily varied in Morin's experiments, a new set of three or more supporting points came into play, the small surrounding areas of which were not sensibly different from the corresponding areas formerly, under which circumstances the apparent area of contact would of course make no difference in the resistance.

To accept the above explanation of the reasons for Morin's results as they bear upon the first and second laws of friction, it would be essential to assume that Morin's contact surfaces did not fit well. Whatever the probabilities, we may very well continue in this assumption when we come to examine the third law. In this connection the following experiment is submitted: A suitable shaft was loaded at its middle by mounting thereon a brass disk, and at each end it was properly journalled to run in half-bearings made of pure copper. Provision was made for lifting this rotating system clear of the copper bearings into contact with a moving belt, which imparted to the system a rapid motion of rotation. When the speed of rotation became as great as desired the shaft was lowered into contact with the copper half-bearings and the lift disengaged, while the system continued its rotation freely except for the friction of the journals. Its performance was then noted carefully until it came to rest. By means of an instrument hereinafter described it was possible to observe the events at which the disk and shaft came to certain known speeds. And by counting the times between these events, a retardation record was possible. In the following table are given values of times in seconds during which the speed fell from a certain number of revolutions per second to a speed of five revolutions per second slower. The figures at the headlines designated by *N* are the numbers of the periods between events, reckoning the first period as that between the event of rest and the event at which the speed was five rev. per sec., etc.

W means cleaned and lubricated.

U means lubricated.

Each horizontal line is a retardation record, and the records were performed in the order in which they are set down in the table.

Undeniably, in the first portion of the table, the lengths of the periods—and therefore the frictional resistances—are nearly constant for all speeds from the high one at starting down to very near the point of rest. Undeniably also in the latter portion, there is a persistent lengthening of the periods 2, 3, 4, and 5, making the friction seem to depend upon the speed. The corresponding change in the conditions was manifestly one of mechanical fit. Toward the end of the experiment the journal became more and more perfectly "worn to" the bearing.

This probably shows, with what we have shown above, that Morin's laws may be explained as being those obeyed by bodies in contact only at small point areas whereat they mesh deeply: that the modern laws are obeyed by bodies in better mechanical contact, but meshing less deeply.

So far it has been shown that, contrary to the announcement made by M. Morin, the resistance may not always be independent of velocity. We shall now turn to an investigation carried forward for the purpose of finding out whether or not there is a definite law of dependence, such as the one quoted above, or whether the variation appears as characteristic of the given material.

A number of alloys were made and ingots cast into bars of suitable shape, from which sections were cut, polished and examined with the microscope. Suitable half-bearings were then prepared for the testing machine, and from these the frictional retardation curves were obtained. The following method was used for observing the manner in which the friction varied with the speed:

From the consideration of some of the difficulties with the methods of Thurston, Tower, Denton, Wellington, and Chatelier, and of the great differences noted in the results from them, considered as absolute measurements, together with what was noticed in the microscopic examinations of bearings which had been some time in operation, the writer was led to seek a solution of the questions of friction through other means. That which had been observed by others, indeed, that which might have been accepted as the truth merely by process of deduction from probability, was confirmed upon examination of a large "white-metal" bearing, which had been some time in operation in an ordinary shop situation. In this case the original longitudinal markings made in fitting the journal were visible over the greater portion of the cylindrical surface of the white-metal step. Indeed the very smooth portions, together with those where abrasion had occurred, indicating places where the journal had actually touched the bearing, in metallic contact, comprised an area not greater than 2 per cent. of the whole surface. Of this small percentage a large portion was plainly due to the abnormal presence of dust or grit, these places being near the ends: so that the really smooth-worn area, situated further inward, was a very small fraction of the apparent area in contact. To be fair, it should be said that a second, smaller bearing examined exhibited indications of a much greater area as having been touched by the journal. But in this latter case the markings showed great furrows, due to abrasion and to the further fact that the journal was very untrue, exhibiting irregularities, errors of machining. It was not thought that this latter investigation controverted the obvious fact deducible from the former, viz., in practice, and therefore in machines designed to measure the force of friction, which imitate practical conditions, great uncertainty must exist as to the *real* area of the contact surface. If, then, any law of friction depended upon this area, its truth or falsity could hardly be demonstrated by means of an ordinary practical bearing.

FIG. 2

It occurred to the writer to attempt to measure the force of friction by means of the retardation it produced in the speed of a rotating shaft loaded by having mounted concentrically upon it a heavy disk, when the rotation was subjected to no appreciable retarding or other force except the friction of the two journals, at the shaft ends, in simple half (or less) bearing steps (see Fig. 1). For observing the fall in speed an instrument due to Mr. F. H. Ball, Jr., which may be called the vibrating tachometer (Fig. 2), was em-

ployed. The latter consists essentially of a long stiff steel bar, fixed at one end, horizontally, and made to tremble by means of an instantaneous contact electro-magnetic arrangement similar to that employed in electric bells. At the free end is attached to the bar, in a vertical plane, a screen containing a narrow horizontal slot. When stationary, this slot just opposes an exactly similar one cut in a stationary screen fixed in the vertical plane, parallel and very near to the screen carried by the vibrating bar. When the movable screen is set vibrating at a sufficiently high frequency any recurring or cyclic motion observed through the stationary screen will exhibit at successive distinct instants of time the particular phases of its action which are occurring when the vibrating and stationary screens are opposed. It follows that if the frequency of the vibration is equal to that of the cycle observed, the summation of all the effects upon the eye will give a vision of the system whose cycle is being observed, which is that of the system when stationary. The same sort of vision will be observed when the recurrence of the system has a frequency any whole number of times as great as that of the vibrating screen, within the power of the eye to recognize form, stationary, produced by successive instantaneous images at some interval of time apart when disturbed by visions of the same form in motion during those intervals. Also, in case the cycle observed is symmetrical and certain portions superposable to fit upon others, then, when the system recurs at other frequencies than any of those mentioned above, similar images will be visable, due to instantaneous superposition of like phases. Lastly, another stationary effect will be noticeable, in the latter case, when certain phases are *partly superposed*, recognizable from some peculiarity of figure due to the instantaneously superposed images. As applied to the case in hand, by specially marking the rotating disk, and noting the times between the recurrences of stationary images, while the motion was retarded only by friction, from a knowledge of the frequency of vibration of the screen, the retardation of the motion of the rotating system could be computed. When these times were plotted against speeds as ordinates, the resulting curve furnished a graphical record of the friction throughout the performance. Let

φ = friction angle.

F = the force of friction at periphery of journal.

W = weight of the rotating shaft and disc.

K = radius of gyration of the rotating mass

r = radius, in feet, of the journal.

a = linear retardation in ft. sec.^{2}

n = fall of speed in r.p.m. in time t.

Then $a = \dfrac{2\pi nK}{60t}$ and $F = W \sin \varphi$.

The equality of moments is

$$\left(\frac{aW}{g}\right)K = Fr,$$

$$\frac{F}{W} = \frac{a}{g} \times \frac{K}{r} = \sin \varphi = \frac{\pi K^2 n}{30grt}$$

$\tan \varphi = \mu$ = coefficient of friction.

But $\dfrac{n}{t}$ = slope of the retardation curve $= \tan \alpha$.

The friction angle is so small that we may say

$$\sin \varphi = \tan \varphi - \mu$$

very nearly. Making these substitutions, we have

$$\mu = \frac{\pi K^2}{30 g r} \tan \alpha,$$

or the coefficient of friction is at every point very nearly proportional to the slope of the curve.

Two bearing steps were fastened to the sides of a steel frame supported at a convenient hight. The rotating shaft was ¼ inch in diameter at the middle and was cut down to ¼ inch in diameter at each end where the steps were fitted. In order to reduce to a minimum the liability of having large apparent areas of contact, but small real ones, these bearing steps were cut to a longitudinal width of about 0.04 inch, while their circumferential arc embraced considerably less than half of the ¼-inch journal. The journal was slightly scored to permit only a small amount of axial motion. At the center of the shaft was mounted a solid brass disk ⅝-inch thick and 5 inches in outside diameter. The weight of the disk and shaft was 4.14 pounds. At a short distance away on each side of the disk a journal ½ inch in diameter was cut, which ran in bearings at the ends of the two arms which were pivoted at a short distance away to the frame of the machine. Attached to these a handle was provided, by means of which the arms could be raised, hooking their ends under the shaft in the journals provided, thus enabling the observer to raise the rotating system clear of the test bearings into contact with a moving belt, and when at speed to set it down again upon the test bearings and, unhooking the arms, to allow the system to spin freely, except for the friction, when its performance could be observed by the tachometer, suitably arranged a few feet away. The source of power was a small electric motor, provided with a switch for stopping it quickly at will; a round belt from the motor's pulley traveled over a guide pulley at each end of the frame above mentioned. This belt ran in a horizontal direction an inch or so above the shaft, so that when motion was to be imparted to the rotating mass, it was only necessary to hook the arms under it and raise it clear of the test bearings until a circumferential groove in the shaft engaged with the belt, setting the system into rotation.

Alternate quadrants of the brass disk were blackened and the remaining two whitened. Then obviously what may be called a velocity "node" would occur when its speed was such that it made one-half a revolution in the same time in which the screen made one-half oscillation; also when it made a whole revolution per half-oscillation; and also when it went one and one-half revolutions, etc., or nodes would occur at shaft speeds of 1, 2, 3, 4—n times the frequency of oscillation. It was also possible with a little practice to observe the nodes at greater speeds, these being distinguishable from a certain appearance of uniformly gray color on the disk, apparently stationary, as in the case of the half-nodes. These occurred when the disk revolved at one-fourth a circumference in the same time that the screen made a half-oscillation.

Thus it was found possible to observe the change in speed of the disk after setting it free on the test bearings by observation of the times between the "node" events, which occurred at speeds which could be reckoned as some simple multiple of one-half of the frequency of vibration of the screen. With the favorite arrangement, for example, the frequency of oscillation of the bar was about 10 per second; so that nodes occurred at disk-speeds of 5, 10, 15, 20 . . . . . $\dfrac{10n}{2}$ revolutions per second.

At first it appeared that since great uncertainty must exist as to the amount of area really in metallic contact in large bearings, it would be well to eliminate as much of this uncertainty as possible by reducing the bearing area. Be it well or ill, it has been assumed that with smaller areas to attend to, very probably the *apparent* area would represent more nearly the *true* area in contact. Hence it was decided to work with small areas. But this implied small normal forces and also very light resistances. Difficulty loomed up when an attempt was made to conceive apparatus whose own resistance would be inconsiderable enough not to effect very adversely any result for the friction itself. In the method adopted the observing apparatus was entirely detached from the system being observed, as was every other disturbing influence except the atmospheric friction, and whatever vibrations were set up by the spinning system itself.

Another part of the work lay in the field of metallurgy. In that connection a number of alloys were made, in which the major number of the different structures which had been noticed might be expected to exist. A number of these were not unlike empirical bearing metals of commerce. These were utilized in the present investigation in the following manner: To a bearing alloy, which usually was very rich in some one of the softer metals, as lead, tin, aluminum, copper, etc., a third constituent would be added in three different proportions. The plan was first to add to the bearing alloy a mere trace of a third metal, which might be supposed

	Time in dropping from a speed, in r. p. s. of										
	50 to 45	45 to 40	40 to 35	35 to 30	30 to 25	25 to 20	20 to 15	15 to 10	10 to 5	5 to 0	Total.
A.	10	10	11	11	13	15	16	17.5	17.5	12	133
B.	13.5	12.5	11	14	14	16	21	30	17	15	164
C.	11.5	14.5	15	17	20	21	23	29	19	16	168
D.	13	14.5	16	17.5	21	25	27	28	28.5	18.5	209
E.	11	14.5	16	16	18	21	23.5	27.5	31	21	199.5
Number of period	10	9	8	7	6	5	4	3	2	1	178.3*

* Mean of totals.

Performance.	Time in dropping from a speed in r. p. s. of									
	50 to 45	45 to 40	40 to 35	35 to 30	30 to 25	25 to 20	20 to 15	15 to 10	10 to 5	5 to 0
A.	13.4	13.4	14.7	14.7	17.4	20.2	21.4	23.4	23.4	16.1
B.	14.7	13.6	12	15.2	15.2	17.4	22.8	32.8	18.5	16.3
C.	11	13.9	14.4	16.3	19.2	20.2	22	27.7	18.2	15.3
D.	11.1	12.3	12.8	14.9	17.9	21.2	23	23.8	24.3	15.7
E.	9.9	13	14.3	14.3	16.1	18.8	21	24.7	27.7	18.8
Totals.	60.1	66.2	68.2	75.4	85.8	97.8	110.2	132.2	112.1	82.2
X.	12.0	12.6	13.8	15.1	17.1	19.6	22.1	26.4	22.4	16.4
Number of period	10	9	8	7	6	5	4	3	2	1

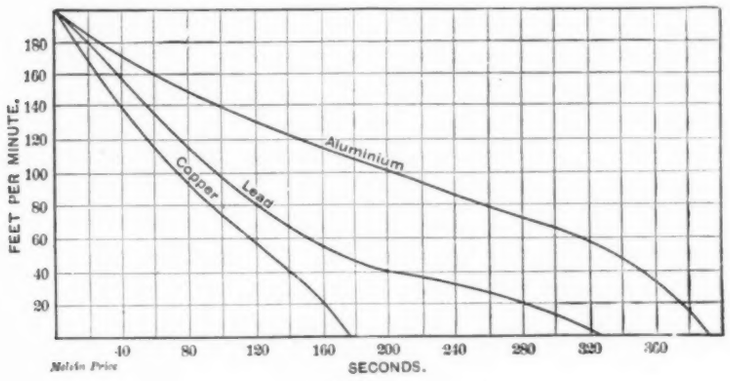


FIG. 4

PURE ALUMINIUM.

Performance	Time in dropping from a speed in r. p. s. of								
	45 to 40	40 to 35	35 to 30	30 to 25	25 to 20	20 to 15	15 to 10	10 to 5	5 to 0
A.	34	39	43	49	52	46	39	25	15
B.	32	41	47	52	59	59	34	30	16
C.	35	40	50	55	65	61	34	30	15
D.	34	40	49	54	56	57	35	35	16
E.	32	37	45	48	60	47	30	32	17
X.	33.5	39.4	46.8	51.6	58.4	53.8	34.5	30.4	15.9
Number of period	9	8	7	6	5	4	3	2	1

PURE LEAD.

Performance.	Time in dropping from a speed in r. p. s. of								
	45 to 40	40 to 35	35 to 30	30 to 25	25 to 20	20 to 15	15 to 10	10 to 5	5 to 0
A.	26	19	11	10	13	33	52	76	66
B.	13	11	13	13	13	16	31	59	43
C.	26	25	22	29	38	45	57	98	53
D.	27	12	36	37	40	33	51	77	31
X.	22.9	16.8	20.1	21.5	24.8	31.1	48	79.1	50.9
Number of period	9	8	7	6	5	4	3	2	1

to change merely the grouping of the atoms of the other two metals without developing any new crystalline arrangement. Next a somewhat larger quantity of the third constituent was added, which might either develop a new network arrangement of the two excess metals, or develop small crystals of a chemical compound with one of these metals. Then a still larger amount of the third constituent was added, which was thought would bring out a larger number of crystals of chemically combined metals, or in some other way change the microstructure. It was hoped in this way to obtain examples of changes effected by the presence of third constituents in bearing alloys which might in some measure correspond to exchanges in the higher orders of asperity upon polished sections.

Specimens of these alloys were cast in an iron mold in the shape of a bar ½ inch x 5/16 inch x 4 inches, which was planed to a triangular cross-section, and two sides of the prism thus formed were polished and examined under the microscope, before etching, in order to make out as far as possible the harder portions, which then showed in relief. Then the face was etched and further examined.

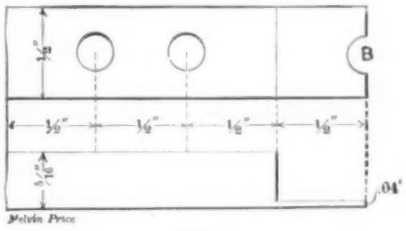


FIG. 3

For the friction test, from a bar like the one whose dimensions were given above, there were shaped two thin sliced bearings, of about the dimensions of the accompanying sketch, which were bolted to the sides of the frame of the testing apparatus above described, where the bearing surface *B* supported the journals at the ends of the spinning shaft, and was the test surface. The journal was run in these bearings until it could be seen just which were the contact areas, and these were then taken down slightly with emery cloth and the journals again run upon the bearings, and the process repeated until, so far as could be observed, a perfect fit was attained. Then the retardation curves were taken in the manner indicated above.

At first it was believed that the true frictional characteristics of the solid materials would be best exhibited in the absence of unguents. But after numerous trials under such conditions, and also under conditions of scanty lubrication, it was decided that at least for the pressures and speeds commonly employed, the amount of abrasion always present made it seem clear that whatever results might be thus obtained would be some kind of index of rupture, or inner friction, in-

stead of resistance to sliding or outer friction. Now the author was well aware of the fact that it had often been said that the identity of the solid material was lost whenever flooding of the bearing was resorted to. Thurston seemed to believe this. Charpy had found it so, and noticing the destructive abrasion in the attempts where no unguent was used, thereupon abandoned the friction test. But Professor Goodman's atomic theory was based upon tests where little or no oil was used. The author does not find a complete description of Goodman's experiments, but his own efforts at unlubricated friction determinations have been so absolutely worthless as to make it impossible to place entire confidence in the law so obtained, notwithstanding Goodman's positive statements. Accordingly, in the experiments here recorded the bearings were supplied with as much oil (mineral) as would adhere to the journals and to the test bearings after each one or two performances. Such efforts at giving the rubbing members as great an amount of the constant unguent as they would "hold" constitute the whole of the efforts made at uniformity of conditions regarding lubrication.

Difficulty at once appeared when it was desired to interpret the large mass of data obtained. Uniformity of results at first appeared among the impossibilities. The friction of the bearings was variable; worse, it was capricious in its behavior. However, as performances were repeated, great care being taken, with cleanliness and uniformity of lubrication, it was noticed that for a given metal the latterly obtained curves *tended toward uniformity of shape*, although absolute values of resistance always differed, sometimes only slightly, sometimes considerably. In view of this it was decided that certain performances should be elected from the masses, for each metal which should reflect most nearly the frictional qualities of that metal. In electing these performances at least two qualifications were recognized as essential: (1) Recognizing the fact that probably abrasion caused the majority of the caprices above noticed, and that probably always abrasion increased the resistance; and feeling also a desire to find some basis of comparison of metals as to their absolute resistance, it was decided to elect performances from among the *best* for each metal, or those showing the lowest resistances. (2) Whenever there appeared a decided but uniform tendency toward some peculiarity in the variation of the resistance, it was decided to select those performances which emphasized these peculiarities most.

As an example, in the case of pure copper, a complete log of whose performances appears above in the discussion of mechanical fit, in the latter part of the log there is noticed a decided tendency toward a lengthening of periods 2 and 3. The running times also show these performances to indicate lower resistances than are indicated by the first portion of the log. Hence it was decided to select as typical of pure copper performances from among those latterly tabulated. Accordingly the last two and the last but three were chosen. Of these, one shows decidedly lower resistance (greater time) during period 3; one shows practically the same resistance in the two periods 2 and 3, and the third shows slightly lower resistance in 2 than in 3. But in the last fourteen performances, eight have lower resistances in period 3 than in period 2, four show the reverse condition, and in two they are tied. Accordingly the last performance but seven, showing marked anti-friction in 3, was chosen, it being one of the best performances of copper. The last but thirteen was the fifth choice made, and in this periods 2 and 3 are tied. For the ten periods, counting from the

ALUMINIUM SERIES.

AL (80). CU (15). MN (5). No. 1.

Performance.	Time in dropping from a speed in r. p. s. of											
	60 to 55	55 to 50	50 to 45	45 to 40	40 to 35	35 to 30	30 to 25	25 to 20	20 to 15	15 to 10	10 to 5	5 to 0
A.	18	16	18	20	20	26	28	38	50	50	36	14
B.	....	....	....	23	28	34	38	49	56	57	39	15
C.	....	....	....	20	24	27	34	38	43	33	36	13
D.	....	....	16	19	20	23	26	39	52	51	34	13
E.	....	....	....	....	25	28	34	40	43	38	27	13
X.	....	....	17.3	20.1	23.4	29.5	32.1	40.6	48.6	45.4	34.3	13 6
Number of period.	12	11	10	9	8	7	6	5	4	3	2	1

AL (94.9). CU (5). MG (.1). No. 2.

Performance.	Time in dropping from a speed in r. p. s. of									
	50 to 45	45 to 40	40 to 35	35 to 30	30 to 25	25 to 20	20 to 15	15 to 10	10 to 5	5 to 0
A.	22	13	19	12	18	22	24	26	27	16
B.	....	....	19	17	13	20	21	24	23	13
C.	....	....	22	20	17	20	22	26	21	14
D.	18	16	16	15	15	14	19	20	18	11
E.	21	19	19	17	14	20	20	24	21	21
X.	20.6	16.4	19	16.3	15.9	19.1	21.3	24.4	22	14.9
Number of period	10	9	8	7	6	5	4	3	2	1

AL (90). CU (5). SB (5). No. 3.

Performance.	Time in dropping from a speed, in r. p. s. of									
	50 to 45	45 to 40	40 to 35	35 to 30	30 to 25	25 to 20	20 to 15	15 to 10	10 to 5	5 to 0
A.	15	17.5	15.5	16.5	17.5	17	13.5	15.5	14	11
B.	16	17	19	20	19	19.5	20.5	16.5	15.5	12
C.	15	15	14	13	13.5	14	16	19.5	16	12
D.	13.5	13.5	14	11	11.5	11.5	13.5	15.5	16	12
E.	12	12	13	12	12	11.5	16	13.5	14	12
X.	14.3	14.9	15.1	14.5	14.6	14.5	15.9	16.1	15.3	11.9
Number of period	10	9	8	7	6	5	4	3	2	1

AL (84). CU (15). MN (1). No. 4.

Performance.	Time in dropping from a speed, in r. p. s. of									
	50 to 45	45 to 40	40 to 35	35 to 30	30 to 25	25 to 20	20 to 15	15 to 10	10 to 5	5 to 0
A.	12	11	12	13	13	12.5	13	14.5	13	12
B.	....	....	....	12	11	12.5	11 5	12	13	12
C.	....	....	....	....	12	12.5	14 5	13	14	11
D.	....	....	....	13	13	14	14 5	16	15.5	11
E.	....	....	12	14	14	15	14	14.5	14.5	13
X.	12.2	11.2	11.7	12.9	12.6	13.3	13 5	14	14.1	11.9
Number of period	10	9	8	7	6	5	4	3	2	1

point of rest, the chosen performances are set down in the following table:

It was now assumed that these were similar curves, *i. e.*, except through error of observation or peculiarity of condition, they differed only in the scale of times. Accordingly they were reduced to the same scale in the following manner: The total running times for each of the five performances were found by adding, in each case, the times for the ten periods. The results are found in the table of totals. The mean of these was taken as a typical total and was made the basis of the reduction scale by which the running times for each period were modified. Thus the mean of totals = 178.3. Accordingly the performance was modified by the factor for *A*, for *B*, and so on, making each horizontal line, when modified, total 178.3. The resulting table of modified performances is as follows:

It was now assumed that the performances, so modified by the scale factors, were directly comparable. Accordingly means were taken of running times for each period (vertical columns), and in the horizontal line, *X*, we have the result. This may be regarded as a mean or composite performance. It is upon this curve, so found, that I have depended for graphical indication for the behavior of frictional resistance of pure copper. Let us see how it compares with the observations made above, when the five performances were chosen from the mass of data in the log. The considerations upon which these were selected are seen to be reflected in the composite curve: (1) The lowest resistance is noticed in periods 2 and 3, the very lowest in three. The value in period 3, 26.4 in time of running, stands well with the unmodified values. As a numerical check, the total running time in curve *X* foots up 177.9, slightly different from the mean of the totals 178.3, used as a scale basis. The difference may be attributed to neglect of decimals.

This method was applied to all metals tested and the following curves plotted:

Curves showing the Variation of Frictional Resistance with the Speed. Noticing first the curves of the pure metals, it is at once apparent that aluminum, copper and lead have similar speed friction variations in general, but their curves are quite different in detail. Generally, in all three, the resistance is high at high speeds, becoming less as the speed lowers, but rising again near the vanishing point of speed. In detail, at high speeds, there seems to be no striking differences, except in the amount of resistance, but at middle speeds lead exhibits faster variation than aluminum and copper, although it is between them in average amount of resistance. Between aluminum and copper the difference noted is that the variation of aluminum is much more gradual, or its resistance is most nearly constant of the three. It is at the lower ends of the curves that the most striking differences in detail are noticed. The aluminum comes down abruptly when 20 ft. per min. is reached, lead consumes more than three times as much time in coming to rest, while copper, though not so abrupt with reference to the other curve, is not very different from aluminum in actual time of coming to rest from the above mentioned speed.

The resulting curves for these three metals are not at all similar. A scale factor applied to any one which would make the total running times equal would show the other coördinates vastly unequal, This has the effect of impressing us with the fact that the metals have frictional individualities.

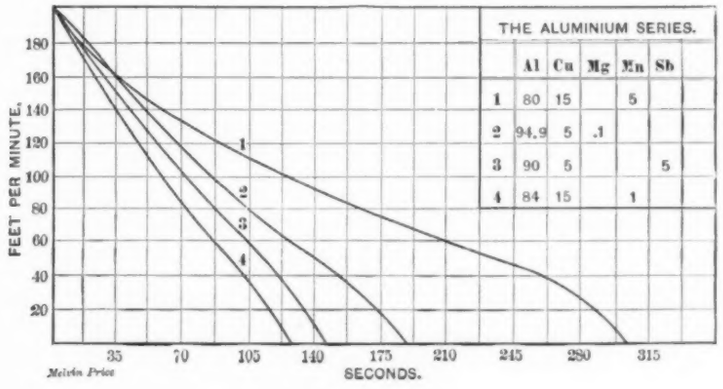


FIG. 5.

In the *aluminum series* we are first impressed by a general similarity at low speeds, though the abruptness differs greatly in degree; a similarity at middle speeds, but in this instance it is constancy and not variation; and by some peculiarities exhibited at the higher speeds. Curves 1 and 2 have opposite qualities at high speeds, while 3 and 4 are similar, constant like their middles, and unlike 1 and 2. May this difference be attributed to the fact that in 1 the third constituent is manganese and in 2 it is magnesium? And if so, is the fact due to abrasive conditions, or effects, or to some one of the orders of asperity? More will be said about this matter in the later discussion of results.

TURKISH PATENTS

Messrs. W. P. Thompson & Co., patent agents, Liverpool, write: "As is probably well known, the Sultan frequently, in an arbitrary manner, changes the procedure and regulations as regards patents. Some months ago he decided that all the annual taxes on patents or trade marks were to be doubled, and that this should apply to patents and trade marks already registered. Our agent in Constantinople went at once to all the principal embassies and laid the matter before them, and we have learned from him to-day that at the instance of the ambassadors, the Sultan has withdrawn his irade as far as regards all patents and trade marks actually on the register, while continuing the irade in force for all new matters. It will be remembered that some years ago the Sultan gave orders that all patents in any way relating to electricity should be refused as contrary to law and order. In a similar way at one time patents for photography were refused because the Mohammedan law forbids in the most emphatic manner 'the making of a likeness of anything that is in the heavens above, or in the earth beneath, or in the waters under the earth.' Both these restrictions have, however, been greatly relaxed."—*The Machinery Market.*

Gossip is a humming bird with eagle wings and a voice like a foghorn. It can be heard from Dan to Beersheba and has caused more trouble than all the bedbugs, ticks, fleas, mosquitoes, coyotes, grasshoppers, cinch bugs, rattlesnakes, sharks, sore toes, cyclones, earthquakes, blizzards, smallpox, yellow fever, gout and indigestion that all this great United States has known or will know when the universe shuts up and begins the final invoice. In other words, it has got war and hell both backed up in the corner and yelling for ice water.—*Guernsey (Wyo.) Gazette.*

One can often bandsaw two or more thicknesses quicker and better than one, and can generally nail the pieces together, outside the pattern, in such manner that the nails will hold them till the last cut is made. Nailing inside the pattern is not only open to the objection that it mars the work, but pieces at all slender are liable to be split in taking them apart.—*The Wood-Worker.*

A company recently organized in Paris proposes to place on the streets of the French metropolis 250 Renault 8 horsepower, two-cylinder gasolene motor cabs. Some of these vehicles are already running, and it is promised that the rest will be on the streets before the first of the year. The rates charged are slightly higher than those charged for horse cabs.

CORRESPONDENCE

Discussing Phases of Machine Design and Construction

A Rig for Boring Large Pulleys

Our largest lathe is only 24 inches swing and as we often have large pulleys to rebore and bush it was decided to fix up an inexpensive rig for doing it. The 24-inch lathe has a 2¼-inch hole through the spindle. It is situated under a shed so a pattern was made for the girders—shown at Fig. 1—to reach from the floor to the joists overhead. At Fig. 2 is shown the sole plate to which they were bolted. This was set on a concrete block at the back of the head in line with the centers of the lathe shown at Fig. 3.

Pulleys *P* to be bored are clamped to the column *C* next to the lathe and are

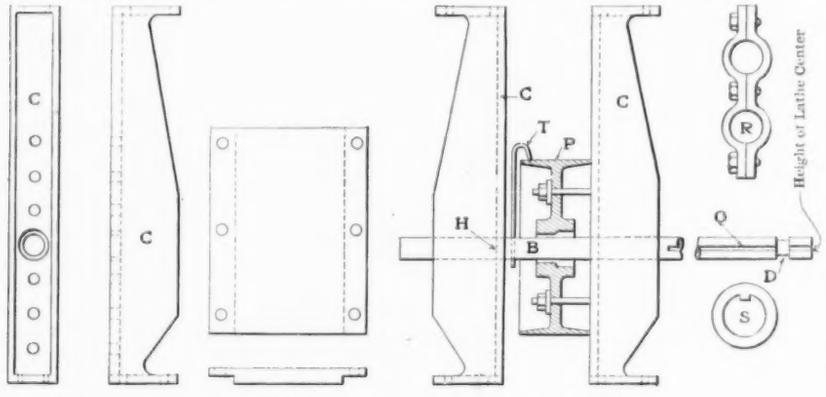


FIG. 1 FIG. 2 FIG. 3

A RIG FOR BORING LARGE PULLEYS

set by a tram *T* clamped in the boring bar *B*, the bar being turned to successive positions. The bar *B* is supported in the hollow lathe spindle and in the bushed hole *H* in the column *C*.

The bar is driven by a steel sleeve *S* having a key firmly dovetailed into it; the boring bars being keyseated at *Q* for some distance on the end toward the lathe. This sleeve *S* is held in the lathe chuck. The bar is fed by the lathe carriage to which it is attached through a double collar *R*. This collar clamps around a boring tool held in the lathe tool post and embraces the groove *D* of the boring bar. As the bar is fed the key of the sleeve *S* slides in the keyseat in the bar *B*.

With this rig, which cost us about $60 to build, we can rebore any pulley up to 7 feet diameter by 24 inches face or less and with the 2¼-inch bar a good heavy cut can be taken as the bar is only about 3 feet between supports. We have a smaller bar for pulleys of 1 15/16 inches original bore which does very well but springs some under heavy cuts.

REPAIR SHOP.

Apprenticeship and the Necessity for Trade Schools

"When you are looking for anything you are sure to find it." This applies to other things than trouble. I am looking out all the time for things that look toward the waking up of the American mechanical public to the necessity of trade schools. James Bell, at page 355, puts forward, without saying so, as good a reason why a trade school is needed as any to be found. To put the matter at the lowest terms a shop is a place to make money in by turning out the greatest possible amount of work. A foreman or manager who was born to get out work is not in more than one case in a hundred fitted to teach, nor does he care to teach. Worse than that, as Mr. Bell points out, he has no time to do it.

It was my fortune, or possibly misfortune, I have not fully decided which even yet, to run for several years a pretty good trade school without realizing it. I thought I was running an ordinary machine shop, but it so happened that I had a foreman who was the one exception to the rule stated above, a man who had a natural gift for imparting knowledge. He could get the work through the shop, too; but that is another story. I used to hire the men in the shop subject to his approval; that is, I took care that every man in the shop understood that it took the two of us to hire a man, but only one to fire him. When I hired a cheap man, say $2 per day or less, it was always for some certain job. Pretty soon after he came in, though, I was sure to find that I was called on to fill his place, and usually just because he had been changed over on to some other kind of work. My setting-up hands would be found at the scrapers' bench, the scrapers might be running lathes or planers; it put things in rather of a confusion, but there was never any lack of a man available to do any job that came along; and worse than that, for us, there never was any question but that the other shops in town knew just where to go to to get good men. We kept a few right along. Just for samples you might say; but we had to pay fancy prices for our own product. We took hardly any apprentices, but the whole shop was on almost an apprentice footing so far as learning was concerned. A man who did not want to go ahead was not likely to stay long, so the whole atmosphere of the shop was more like what I expect to see in a strictly apprentice shop than I ever saw elsewhere.

Right here I want to suggest that a trade school can do a whole lot of good just by taking these discontented chaps who have worked years as lathe hands or bench hands and making all-around machinists out of them. There are lots of them, to say nothing of a hoard of technical graduates from all the schools (except the one I came from of course) who would be glad enough to get shop work that smacked of the real thing.

Have you ever noticed that when a new idea or a new invention is brought to the fore it usually has a certain course? First it is exploited with a booming of cannon. Then it won't work and it is handed down as worthless. Then it is worked over for years and we gradually get accustomed to it and finally it is perfected and we all use it and think nothing of it. That is the way with automobiles. When we first began to take notice of them they were a wonderful thing and we all knew that they would revolutionize the world; then we saw the owners on their backs under them on every country road. Now we are getting used to them and we think it is no more out of the ordinary to see one of them run away than we do to see a horse run away. We have gotten used to recognizing a certain line of accidents that are sure to happen if we drive a horse and we expect them; if we drive a locomotive we are always looking for some

trouble to creep in and in the same way we are getting to realize that a limited number of things, no more disagreeable than happen to a horse, may happen to an automobile.

This may seem like a digression but it seems to me that the idea of an apprentice school has progressed a good deal in the same way. There has been in the past 20 or 30 years a good deal of missionary work done, the idea has been boomed, a number of schools have been started and have been allowed to become engineering schools to a considerable degree; but now when the General Electric Company is running one successfully and Professor Sweet is about to start one it produces hardly a ripple. We take it as a matter of fact, we are ready for it and I hope that if we do not now recognize its absolute necessity that we will soon. ENTROPY.

Diagram for the Speed of Motor Vehicles

The accompanying diagram, which is

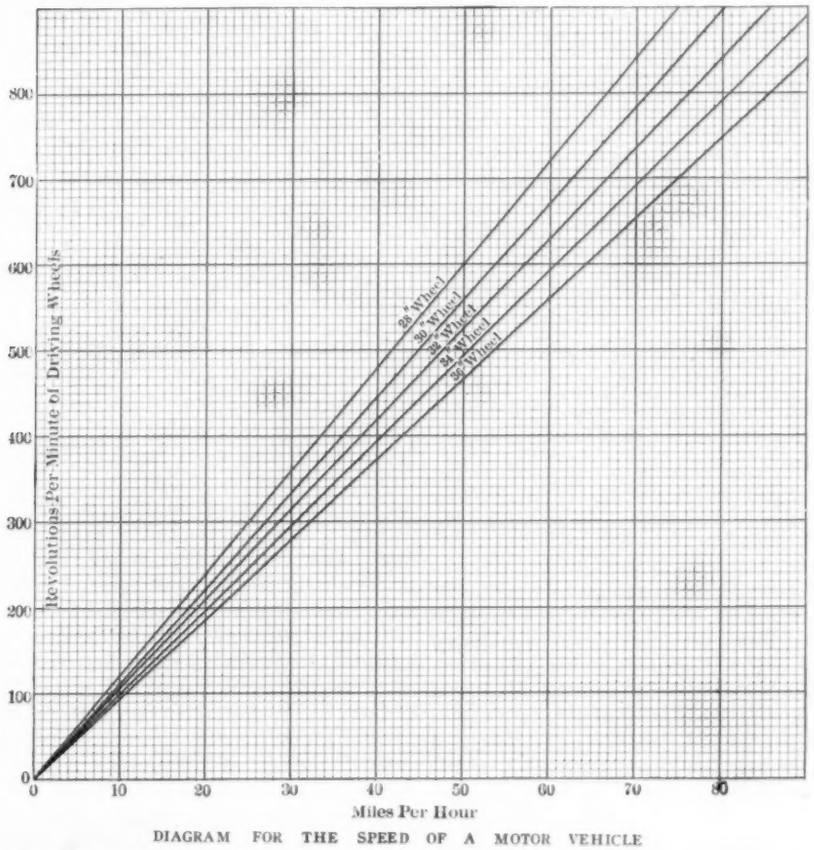


DIAGRAM FOR THE SPEED OF A MOTOR VEHICLE

self-explanatory, gives with sufficient accuracy for all practical purposes the speed of motor vehicles from the diameter and revolutions of the driving wheels.

E. H. REMDE.

Systematic Economy in the Drafting-room

At page 546, Part 1, there was published a much misquoted and misread note to the effect that *the strictly mechanical part of drafting* is carried on by cheap labor.

When a firm employs a dozen draftsmen it will find one or two that *are* draftsmen. It is considered good business practice to take care of these men—not only financially, but in the many little ways that enable an engineer to get through easily with a maximum volume of business. If he wants a list made or a paper copied, a stenographer comes and takes his orders; if it is a tracing to be made, a "cub" is at hand to do the detail; or if it is only a title printed on the printing press, a pencil wanted or a drink of water, a boy comes at the push of a button; the boy gets 50 cents a day, and certainly it is not policy to ask a draftsman to do what can be acceptably done by the boy. The result is that in a well managed drafting office the brains of the concern are kept fresh and keen and the machine parts turned out show it. Incidentally, the steel castings and boiler plate are ordered on schedule time, mistakes do not occur on the drawings, and the relations between the shop and drafting room are most cordial.

GEORGE F. SUMMERS.

Clamping the Tail-Spindle

It is generally understood that the common method of clamping the tail-spindle of the engine-lathe is not quite satisfactory. Referring to Fig. 1, the clamp screw at *A* closes the slotted barrel at one end; but when the slot is made in the usual way, the clamp cannot close the barrel

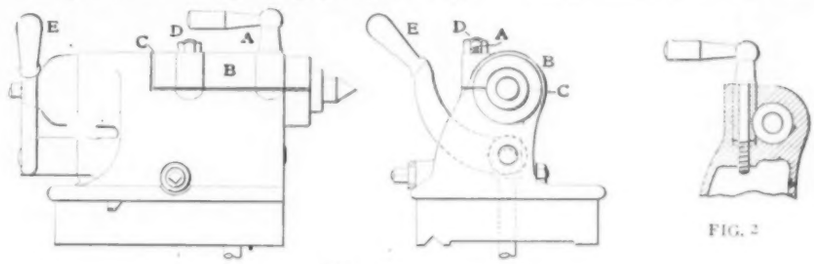


FIG. 1

FIG. 2

CLAMPING THE TAIL SPINDLE

tightly at the other end, for reasons too obvious to mention. Furthermore, one screw is not sufficient even when the cross slot is added as shown. The method illustrated in Fig. 2, which has been adopted by some designers to dispense with the slot, does not, in my opinion, remedy the weakness of the clamping device. This weakness is quite apparent when one attempts to take a cut over a keyway in a shaft.

Some years ago Professor Sweet designed a lathe (which was fully described in the AMERICAN MACHINIST) in which the tail spindle was clamped approximately its full length by means of a slotted bushing fitted to a taper seat in the barrel of the tailstock. The bushing was caused to grip the spindle by some screw device, which forced the bushing longitudinally in its taper seat. This apparatus, as a whole, was rather expensive, and it never came into general use.

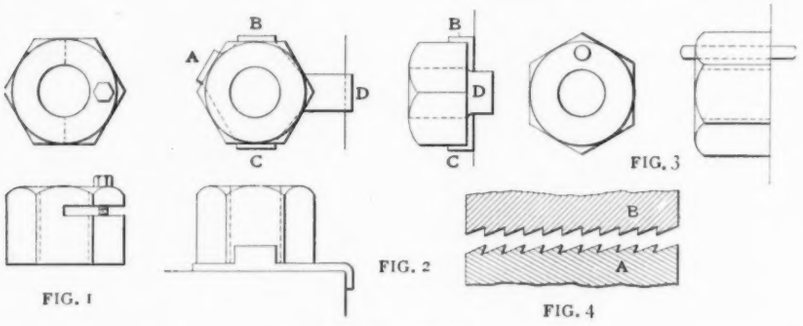
Fig. 1, previously referred to, shows a tailstock which belongs to a lathe designed by me in connection with class work at the Michigan Agricultural College. The barrel *B* has in addition to the ordinary longitudinal slot, the cross slot *C* mentioned above. The clamping device at *A* is of ordinary construction, but at *D* another screw having a common nut is provided. This nut is adjusted to a witness mark for the proper sliding fit of the spindle, and for ordinary work it need not be moved, the lever *A* being sufficient. But for the exceptional job, when everything must be as rigid as possible, both *A* and *D* may be tightened, in which case the spindle will be firmly clamped practically its full length. As a protection against dust, etc., the cross slot is filled with babbitt metal, but the babbitt does not interfere with the clamping.

The eccentric shaft by which the tailstock is clamped to the lathe bed, in this design, lies parallel with the spindle. This arrangement admits of convenient movement of the lever, which is shown at *E*. It has been more than six years since this tailstock was designed, but it is my impression that the arrangement of the eccentric shaft and lever was copied after Professor Sweet's design. Perhaps the editor can tell what issue contained Professor Sweet's article. W. S. LEONARD.

[The article describing Professor Sweet's method of clamping the footstock appeared at page 529, Vol. 21.—ED.].

How to Check Nuts

In connection with Mr. Boehler's article on nut locks at page 214, permit me to add a few which he does not mention, and which I think should be included in making up a list of locking devices. Several of those which he gives are rarely used, so far as my experience goes. His differential-washer device strikes me as very neat, although it is a little expensive, perhaps.



MORE NUT CHECKS

Fig. 1 shows a device which I have found very satisfactory on a forging machine which is subject to considerable shock. The slot is cut in far enough so that the cap screw can bind the nut very hard on the thread. This is old, of course, but good.

Another device is shown in Fig. 2. In this arrangement a wrought washer is used which has several ears on it. When the nut is in place these may be bent with a hammer and chisel so as to embrace the nut, as at *A*, *B* or *C*, and another wing may be bent down around any convenient corner, as *D*. I have never used this, but it looks good to me. I have seen it on automobiles.

Still another is the nut doweled in place, as in Fig. 3. This is not good where the nut must be replaced at any time, but is quite secure.

A light prick-punch mark on the end of the thread is permissible on a good deal of pretty good work and is quite secure, and the nut can be forced off if necessary without spoiling it.

Still a further nut lock is the grip thread used on track bolts by some makers. This is shown in Fig. 4. *A* shows the thread on the bolt in enlarged section showing the undercut, and *B* shows that on the nut. The deformation caused by screwing the nut on makes it grip very hard, and if, as is usually done, a slightly different pitch is used on the nut and bolt, an exceedingly tight grip is obtained through a considerable range of positions. Both bolts and nuts must be very carefully cut, however; not so carefully, though, but that boys are able to cut them by the hundred thousand. This differential thread, combined with the undercut, is not to be confused with the plain and nasty nut cut to a different pitch with ordinary thread and merely jammed on by main strength and awkwardness.

One more device may be worth mentioning. Where a nut is down in a pocket it can be securely held by pouring babbitt metal around it, which can be melted out when the nut is to be removed. This will surely hold in a pocket of somewhat irregular shape. MASON.

[The castellated check nut and the blind set screw, half in the nut and half in the bolt, were also shown by this correspondent; but as they were given in an article previously edited, we have not repeated them here.—Ed.]

Making Springs of Iron Fence Wire

We needed some springs in a rush, and there was no steel wire in the shop or in town. They were about No. 9 wire, 1 inch diameter, ½ inch pitch and 4 inches long. I had them made of ordinary black-iron fence wire, burnt a lot of old leather belting and packed the springs in this, in a good-sized annealing box. Over every layer of springs I sprinkled a little prussiate of potash, and sealed the whole thing with two inches of fire clay. Four hours in the fire and the outfit was dumped in a barrel of cold water. I took one out and dropped it on the floor; it broke in three pieces, and appeared to be hard clear through. The next was dipped in oil and burned off; this also broke, but after two burnings they stood the required test and proved in the end to be better springs than we ever had made in the ordinary way. W. L. McL.

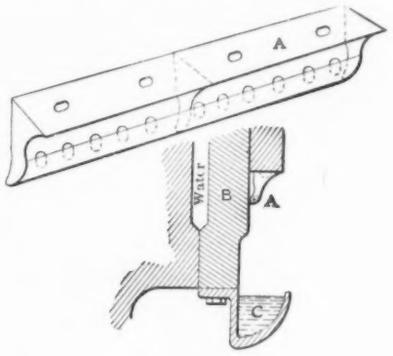
Canada.

An Oil Comb

The illustration shows a design for an oil comb *A* which has been successfully tried as a substitute for the split comb.

It is used on a marine-type engine to carry oil to the guides *B*, dipping at the bottom end of each stroke into an oil receiver *C* at the foot of the guide.

The material is thin sheet brass. It distributes the oil on the upward stroke in



AN OIL COMB

a very effective manner, any condensation water that finds its way to the receiver helping to float the oil into the comb. Emulsification is usually regarded as detrimental to lubrication but I have noticed that in lubricating guides a moderately emulsified oil gives the best results provided, of course, that it does not become stiff, as the comb will not pick up too thick a mixture.

London, England. A. L. HAAS.

Another "Odd" Material

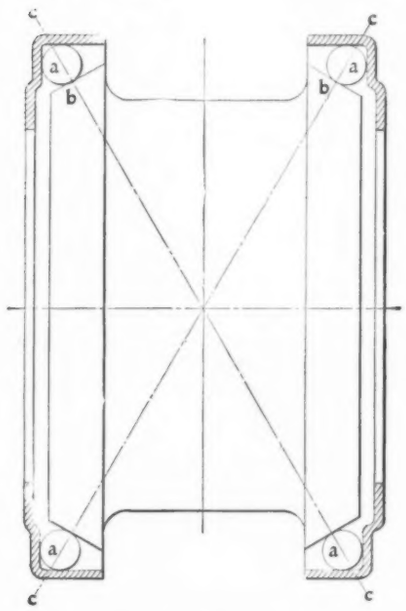
Reading the article "Odd Materials," by Dixie, at page 381, reminds me of a job I witnessed some years ago. In a small village in central New York were several paper mills engaged in making manila tissue. The repairs and renewals in these mills were usually turned over to a local machinist who conducted a small shop and who was possessed of much originality and plenty of horse sense. In one of the mills it became necessary to renew a sponge roll. This was a wooden roll with iron gudgeons inserted in the ends. It was approximately 10 inches diameter by 6 feet long and the entire surface was covered with small sponges, secured by tacks or nails. Owing to the lack of uniformity of the sponges and the manner in which they were secured, the surface was very irregular. As it was up to our machinist to produce a true roll, he did some tall thinking with the following result. Fortunately for all concerned the season was mid-winter with the mercury hovering around zero, so the roll was taken out of doors and thoroughly saturated with water, which in a short time froze, making an ice-surfaced roll. The sponges became as rigid as the ice

itself. In the morning the roll was returned to the shop, which, by the way, was never warmed much above the freezing point, placed in the big lathe and with an ordinary tool and good speed was reduced to a comparatively true surface. When the ice melted, the sponges retained a very good surface. This may not be new to many of your readers, but I never happened to see or hear of a parallel case before or since. The shafting in the machine shop was made of wrought-iron pipe, trued at the bearings, which bearings never had any caps.

H. D. POMEROY.

A Defective Ball-Bearing Design.

The inclosed sketch shows approximately the layout of some automobile hubs



A DEFECTIVE BALL-BEARING DESIGN

which were brought to me some time ago to case-harden. On asking about them later, I was informed they had not been used on account of a defect in design. The defect was a new point in ball bearings to me, and may be to others.

A three-point bearing was used, and the sketch shows the ball cups in section, and the hub with four of the balls *a* in place, *b b* being the ball races of the hub. With the diameters and length shown, the lines *c c* drawn through a point in the ball track on one race and a point diametrically opposite in the track on the other race would be perpendicular, or nearly so to the races at points of intersection When the wheel was assembled, it was found that, although theoretically it would be impossible to move the balls up the conical surface of the race, practically the bearing could not be tightened so but that the wheel could be wabbled half an inch or more.

JOHNSE.

Specialist Versus the All-Round Man

On reading Optimist's letter at page 187 it struck me that there are a few points he has missed, and as he has had his say from the all-around man's point of view, I think it only fair that someone should say something for the specialist. First of all let it be clearly understood that I am a lathe hand, and a specialist, and do not wish to be taken for anything else. I have never been handicapped by Optimist's complaint—natural talent and lots of grit —though I have suffered from quite as bad a complaint, namely, swelled head, and I still have twinges occasionally. The only reason I work at all is for the sake of the wages it brings.

Optimist says that an apprentice boy can only hope to become a specialist, and he goes on to say that this is due to changes in the business and that being an apprentice now does not mean what it did twenty years ago. What I should like to know is why cannot a man be content with the business as he finds it now, and not waste time qualifying himself for the jobs that were going twenty years ago? If he does he'll find when he is fully qualified that he is just about twenty years behind the times. Help to shove the business along now, I say, not stand out and shout that it isn't as good as it used to be. I have served some time as an all-round man, the way of it being this. As I said before, I got the swelled head when I had been on a lathe in a rattling good shop for three years, and thinking I should do lots better anywhere else as I had learned all there was to learn on the lathe in that shop, I engaged as a lathe hand in a small repair shop, a regular "one-horse job shop," as one of our old friends would call it. As there were only two of us machinists I soon found myself up against all sorts of jobs and before I had been there long I was anything from lathe hand to fitter, driller, shaper, belt man down to blacksmith's striker and general mess-about. I did twelve months of that, not because I liked it, but because I think anything under twelve months is too short a time to stay anywhere. I never found much difficulty with the jobs they gave me as long as I kept cool, and I think if a man works in a big shop and keeps his eyes open, even if he is only a specialist, he can do any work he is likely to be given in a small repair shop.

After that I engaged in a first-class tool works at more than double the money, as a specialist and here I mean to stop till they drive me away with a stick. I now have a decent machine in a clean, well lighted shop, plenty of work, plenty of money, a chance of promotion if I am any good at all, and I know how many hours I have to work in a week, instead of working till about 10 o'clock one week and knocking off at four the next. I venture to think that if a man came to our shop and said he was an all-round man and had learned it all in eight different shops in seven years the boss would be afraid to start him, for fear he would rush him out of his job. Then again as I do not work for anything except money, I think that is a thing that should be taken into consideration. Anybody who has had any experience with the bonus or piece-work system knows that it is the rule to earn time and one-eighth to time and one-half, which is surely better than working for bare time. And if the time does not go quite so quickly on a long job as it does on a small one, that is the fault of the man, not the job.

So now, you specialists, if any of you think because you are specialists it is a sign you have not grit, do not worry, for if natural talent and grit make you jump about in and out of eight shops in seven years, it is a good thing the complaint is not more prevalent in the trade than it is. I daresay I have associated with about a hundred machinists from laborers to inspectors in my time and this is the first time I have heard anyone confess to it. And if any of you feel tired because you have a batch of, say, one hundred gears with a limit of 0.0005 in the bore and 0.002 on the top and sides, just gather round and I will tell you a remedy: Take your MACHINIST, read it a lot, think about it a little, and borrow our friend Dixie's specs and look at your job through them, and also listen for the echoes from your own shop as another of our friends hears them in his Oil Country, and if that doesn't freshen up your minds and give you enough to think about, it must be because you have no minds to freshen up. And above all, don't get panicky and think there is a lot more to learn in someone else's shop than there is in your own. You can take it from me that if you are not appreciated in your own shop it is a sure thing you will not be anywhere else, and you have just as much chance of getting a soft snap through knowing a lot about one branch of the trade nowadays, as you have through having a smattering of all the branches.

As for shop associations, I think it depends on the boy and his luck. If the bad men in the shop get hold of him it is ten to one that they make him as bad as they are, but if he sees the error of their ways or is shown them by some friend or shopmate and pulls himself up I maintain he is a much better man for the temptation. If a boy comes through his seven years straight and clean, he ought to think himself highly honored in belonging to the finest and most manly trade going, bar none, whether he may be a specialist or an all-round man.

JACK AND WOULD BE MASTER OF ONE TRADE.

It is said that the normal demand for anthracite coal in the United States is about fifty-five million tons per annum.

Some Features of the Jacobson Gas and Gasolene Engines

The engines from which the details described herein have been taken are made to operate by gasolene, natural gas, manufactured gas, and producer gas, and are made in two styles of governing, namely, hit-and-miss and automatic. They work on the four-stroke cycle.

Fig. 1 is a longitudinal section showing the cylinder construction—the method of support and the removable bushing or liner. The object of this design is to provide for uniform and free expansion without distortion, and the replacement of the wearing part of the cylinder without renewing the cylinder proper, it being practicable to perform this work without disturbing the engine on the foundation. The cylinder is made up of two principal parts, the one forming the outer wall for the water jacket, also the combustion and valve chamber; the other being the wearing part of the cylinder and being in the form of a removable cylindrical bushing made of "semi-steel," about 20 per cent. of wrought steel being used in the mixture, resulting in the production of a metal which is very tough and wears very slowly. It is claimed that the wall of the cylinder maintains a perfectly round shape in spite of high temperatures, and the piston maintains its original shape so

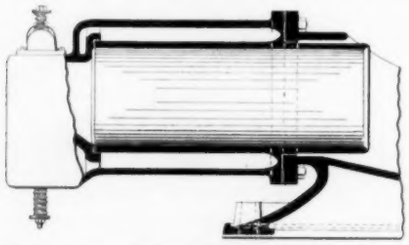


FIG. 1. LONGITUDINAL SECTION THROUGH CYLINDER

that when the engine is in operation the fit is quite close. The design of the water jacket is such that the coolest water is passed to the parts subjected to the highest temperature, so as to equalize the expansion in different parts as much as possible. Where the cooling water contains lime or other scale-forming material, the ability to separate the inner and outer walls of the jacket greatly facilitates cleaning. The gasket of the cylinder corresponding to the gasket usually employed between cylinder and cylinder head is located between the inner end of the bushing and that portion of the outside jacket and combustion chamber forming the cylinder head proper. This gasket is placed in a recess about ¼ inch deep, and is followed into this recess by the end of the bushing which fits in closely, thereby making it impossible for the gasket to blow out sidewise. The gasket is made of asbestos fiber woven over wire mesh.

The opening in the combustion chamber for the inlet valve is directly on top of the chamber while the opening for the exhaust valve is directly below this on the bottom side. The inlet valve is directly over the exhaust valve, and both valves are so constructed as to leave the inner walls and surfaces of the combustion chamber perfectly smooth when all valves are closed, thus doing away with any chance for premature firing due to the presence of slow-burning mixtures of fuel, which is liable to occur when small irregular cavities form a part of the interior surface of the combustion chamber. In proportioning the combustion chamber the ratio of its volume to the piston displacement, or in other words the percentage of clearance, is carefully considered. This, together with the close working fit between the piston and the cylinder, permits of the maintaining of the most desirable compression

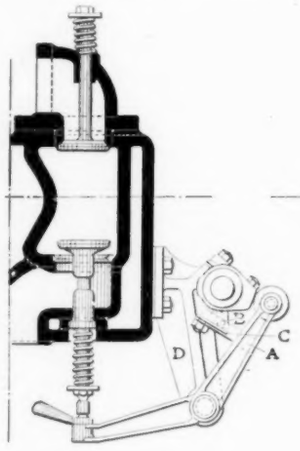


FIG. 2. VERTICAL TRANSVERSE SECTION THROUGH COMBUSTION CHAMBER

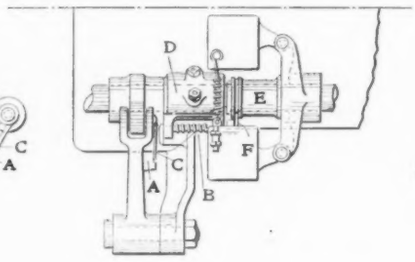


FIG. 3. ELEVATION OF GOVERNOR AND EXHAUST VALVE GEAR

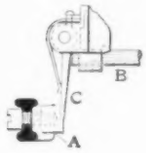


FIG. 4. ENLARGED DETAIL OF LATCH

DETAILS OF THE HIT-AND-MISS GOVERNOR

THE VALVE GEAR AND GOVERNOR OF THE "HIT-AND-MISS" ENGINE.

In this engine the valve gear is operated by means of a shaft parallel to the axis of the cylinder and driven from the main crank-shaft by means of spiral gearing. At the extreme cylinder end of this shaft is a small crank which works the igniter trip. The valve gear and governor are shown in Figs. 2, 3 and 4. The side shaft mentioned carries the cam which operates the exhaust valve, the inlet valve being operated by suction.

The governor is of the fly-ball type and is mounted on the side shaft. The engine being of the four-stroke cycle, the side shaft, of course, runs at half the speed of the crank-shaft, and the governor accordingly runs at this same slower speed, reducing the wear on the parts; the governor balls are, however, supported at a considerable distance from the axis of the shaft, so that sufficient force is developed to operate the governor. Fig. 2 is a vertical transverse section through the combustion chamber. Fig. 3 is an elevation of the governor and the bell-crank which operates the exhaust valve, and Fig. 4 is

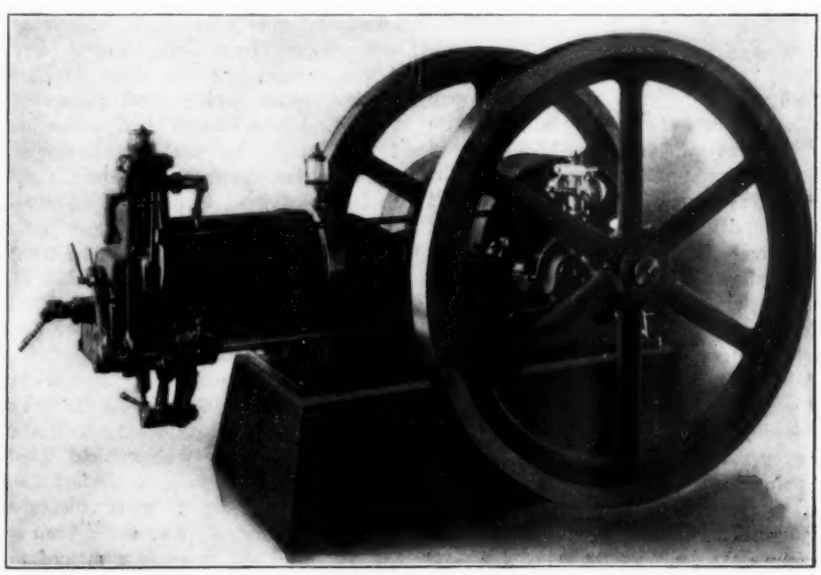


FIG. 5. INTERNAL-COMBUSTION ENGINE WITH AUTOMATIC CUT-OFF

an enlarged view showing a section through the bell-crank arm and the latch and pin by which the governor holds the exhaust valve open and causes the engine to miss. The latch *C* is attached to the side-shaft bracket *D*. Movement of the governor balls away from the axis of the shaft causes the sleeve *E* to be thrust toward the side-bracket bearing *D*, and pushes the yoke *F* attached to the pin *B* toward the latch *C*, thereby throwing the latch close enough to the block at *A*, so that it will engage in the notch and hold the exhaust lever back and the exhaust valve open, and therefore allow the air to thrash back and forth through the exhaust valve while the engine is running by momentum, so that there is no tendency to open the inlet valve and admit a charge to the cylinder. Of course when the speed slows down enough the governor balls move inward again, draw back the pin and release the latch, so that the exhaust valve has a chance to close, and a charge is once more admitted.

THE AUTOMATIC ENGINE.

Fig. 5 is a half-tone view of the single-cylinder horizontal automatic engine, which is designed for driving electric generators, or for any other work requiring close speed regulation. The engine can be belted or direct-connected to the generator. These engines have the same general points in design and construction as the hit-and-miss, but they are provided with an automatic valve gear, as shown in Figs. 6, 7, 8 and 9.

This engine, like the hit-and-miss, has a half-speed side shaft driven by spiral gears. In the end view, Fig. 9, can be plainly seen the eccentric which operates the trip rod for the electric igniter. By means of the thumb screw the ends of the trip can be raised or lowered, so as to give a very minute adjustment of the time of the ignition, which adjustment can be made while the engine is in motion.

The principal difference between the automatic governor and the throttling governor is in the mechanism with which the former is provided for effecting cut-off, the cut-off in this engine being by means of a trip or release mechanism. It is best shown in the transverse vertical sections, Figs. 6 and 7. *S* is the side shaft, carrying the eccentric *T* with rod *R*, the upper end of which engages the outer end of the lever *Q*, which depresses the inlet valve. It is readily seen that the position of the regulation block *P* controls the time at which the eccentric rod *R* is released from engagement with the lever, and hence also the time of the cut-off. The regulator block of course is controlled in position by the ball governor (which can be seen in the general view Fig. 5). The fuel supply is therefore by this means cut off at the

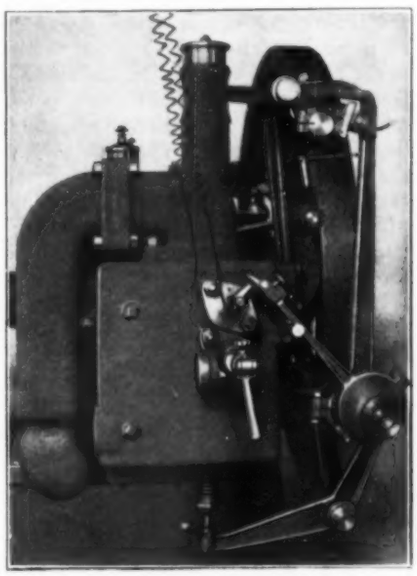


FIG. 9. END VIEW OF SINGLE-CYLINDER AUTOMATIC ENGINE

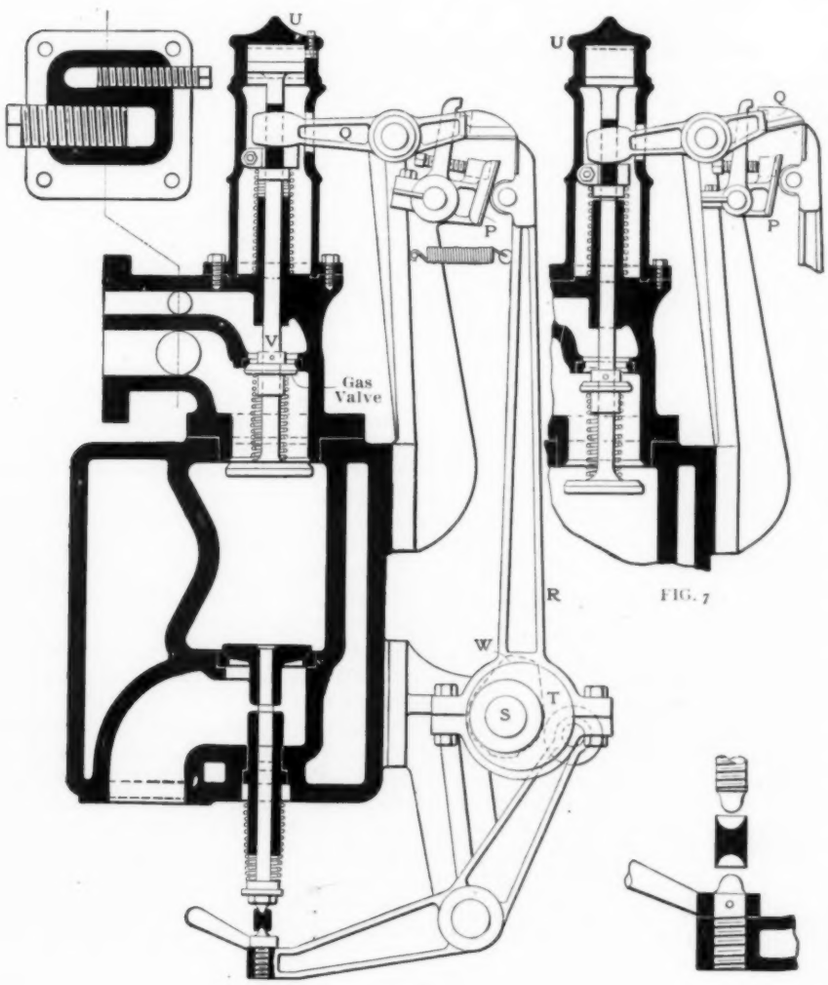


FIG. 6

FIG. 7

FIG. 8

VALVE-GEAR OF THE AUTOMATIC ENGINE

proper point of the stroke. By means of the dash-pot, or air-cushion *U*, the noise and jar caused by the seating of the valves are reduced to a minimum.

The construction of the inlet valves is of interest. The special inlet supply pipe is arranged with a partition, the air entering on the lower left side of the partition, and the gas on the upper side. In the upper left-hand corner of Fig. 6 is a section through the air and gas inlet pipe which shows the screws for changing the area of these passages. The points at which admission commences, for the gas and for the air, are controlled by separate valves, both of which are on the same valve stem *V*, Fig. 6. The lower valve, or air valve—through which of course the gas also passes after being admitted by its own particular valve—is solid on the stem, and the upper valve, or gas valve, is loose on the stem, and is pressed upward by means of a coiled spring. A short distance above the gas valve is a set collar. When the lever presses down on the valve stem *V* the first effect is to open the air valve by an amount equal to the distance between the gas valve and the set collar, as shown in Fig. 6. The cams on the side shaft are so arranged that the air inlet valve opens just prior to the closing of the exhaust valve, thereby causing a sweep of cold air to clean out the combustion chamber. Just as the exhaust valve closes, the set collar has reached the gas valve and pushes it down, opening it and admitting a mixture of gas and pure air to the combustion chamber; this is the stage shown in Fig. 7.

The exhaust valve, as can be plainly seen, is immediately below, and is operated by the (dotted) cam *W*, Fig. 6, on the side shaft. It will be noticed that at the lower end of the exhaust bell-crank between it and the exhause-valve stem is provided with a screw, let into the bell crank. This screw has a steep-pitch thread and is provided with a handle, the effect of turning which is to vary the length of the stem so that when the small elevation at the back of the cam comes to the cam roller it will raise the valve slightly, thereby relieving the compression at just the proper time to facilitate starting the engine. The valve with the lever handle which shows in Fig. 9, just below the igniter, is the lever of a quick-opening valve for use in starting the engine by compressed air.

The valve seats are all arranged to be readily removed and replaced when necessary, and they are easily accessible for grinding.

These engines are built by the Jacobson Machine Manufacturing Company, Warren, Penn.

Society for the Promotion of Industrial Education

Steps are being taken for the organization of a society for the promotion of industrial education. A preliminary announcement has been issued, which is signed by the names of Milton P. Higgins, Norton Emery Wheel Company, Worcester; C. R. Richards, Teachers' College, Columbia University; these being respectively president and secretary of the committee and by Henry S. Pritchett, president Massachusetts Institute of Technology; M. W. Alexander, General Electric Company; James P. Haney, director of manual training New York City; Robert A. Woods, director South End House, Boston; Leslie W. Miller, principal Pennsylvania Museum and School of Industrial Art, Philadelphia; J. Ernest G. Yalden, superintendent Baron de Hirsch Trade School, New York City; Charles L. Warner, principal Technical High School, Springfield, Mass.; James P. Munroe, Munroe Felt and Paper Company, Boston; Arthur A. Hamerschlag, director Carnegie Technical Schools, Pittsburg; Louis Rouillion, director Franklin Union, Boston; Henry Bruère, secretary Bureau of City Betterment, Citizens' Union of the City of New York.

A meeting will be held in New York some time this autumn, when it is expected that a permanent organization will be formed, and things arranged in such a way as to make some substantial progress.

The practice of making iron castings direct from the blast furnace is said to be increasing in England, excellent results being obtained.

Rope Drives—Various Methods of Arranging Ropes on the Sheaves

BY R. HOYT

There seems to be considerable difference in opinion regarding the various ways of applying rope to the sheaves in rope driving, viz., multiple- or separate-rope system, continuous-wrap or single-rope system with the rope from one of the grooves running on a traveling take-up device, continuous-wrap or single-rope system with the take-up working directly on all the wraps.

The multiple- or separate-rope system on a horizontal drive where the distance between centers is great enough so the

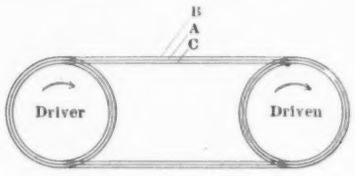


FIG. 1

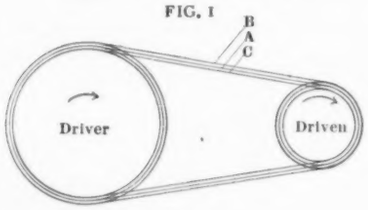


FIG. 2

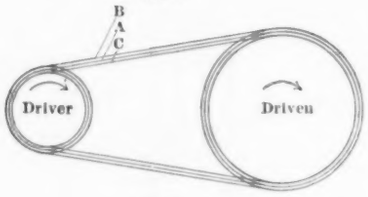


FIG. 3

FIG.

ROPE DRIVES

weight of the rope will give the required tension, having the tight or pulling part on the lower side and the sheaves of the same diameter, as in Fig. 1, should be very satisfactory, as old or worn ropes may be replaced by new ones of larger diameter or some of the ropes may be tighter than others and still not alter the efficiency of the drive. It will be noticed in this case that a larger rope does not alter the proportional pitch diameters of the rope on the driving and driven sheaves; but if one of the sheaves is larger than the other, as in Figs. 2 and 3, and a new or larger rope is substituted for a worn or smaller one or if some of the ropes are a great deal tighter than others, a differential action will be produced on the ropes owing to the fact that the larger or slack rope will not go as deeply in its grooves as the smaller or tight one, and consequently the proportionate pitch diameter of the rope on the driver and driven sheave will be changed. The action will depend upon whether the large or small sheave is the driver. If the driver is the largest and of course assuming the slack or large rope is weaker than the combined tight or smaller ones, then it will have less strain on the pulling side; but if the driver is smaller, then the new or large rope will have greater strain on the pulling side. Whether the driver is larger or smaller, a large or slack rope affects the action oppositely to a small or tight rope. Fig. 3 shows how the action is reversed from Fig. 2.

For clearness we will exaggerate the differences in diameter in the sketches and figure the speeds that the different size ropes would produce. We will take *A* as normal, *B* 1 inch farther out of the groove, producing a difference in diameter of 2 inches; *C* 1 inch deeper in the groove, producing a difference in diameter of 2 inches. In Fig. 1 assume for the normal diameter of driver and driven 40 inches, and 42 inches for *B* and 38 inches for *C*, with a speed of 200 revolutions per minute for the driver. Either *A*, *B* or *C* will give 200 revolutions per minute for the driven sheave, omitting slippage, of course. In Fig. 2 say the normal diameter of the driver for rope *A* is 60 inches and of the driven 30 inches, a speed of the driver of 200 revolutions per minute will give the driven sheave a speed of 400 revolutions per minute. *B*, with the driver 62 inches and the driven sheave 32 inches diameter, will give the latter a velocity of 387½ revolutions per minute. With *C* the driver is 58 inches, the driven 28 inches, and the speed given the latter 414 2/7 revolutions per minute. In Fig. 3 the normal diameter of the driving sheave being 30 inches and the driven 60 inches, a speed of the driver of 200 revolutions per minute will give a speed of the driven member of 100 revolutions per minute. *B*, if the driver is 32 inches and the driven 62 inches, will give the driven sheave a speed of 103 7/31 revolutions per minute. *C*, with the driver 28 inches and the driven sheave 58 inches, will give the latter a speed of 96 16/29 revolutions per minute. So it will be readily seen what effect a large or small rope would have.

There are some who claim that slack ropes will transmit more power owing to more wrap on the sheaves, while others claim that tight ropes are better. I think if one had a drive and the ropes were all slack and they were troubled with the ropes slipping, the first remedy they would try would be to tighten the ropes. But, if the conditions were like Fig. 3, I don't see as it would be particularly harmful to have some of the ropes longer than others; in fact, it might be well, as the longer ropes would not make

a complete circuit as quickly as the shorter ones; consequently the position of the splices would be continually changing. However, it seems more natural, and I should consider it best to have about the same pull on all the ropes, that is, not have them as shown in Fig. 4. In conclusion for the system, it should be noted that it has no means of tightening the ropes except by re-splicing; it is not as well adapted to various conditions as the other forms; it is the cheapest form to install and in some cases should give excellent satisfaction.

With the continuous-wrap system having the rope from one of the grooves pass over a traveling take-up, the latter has a tendency to produce an unequal strain in the rope. In taking up, or letting out, the rope must either slide around the grooves, or the strands having the greatest pull will wedge themselves deeper in the grooves, producing a smaller pitch diameter than the ones having less pull, making a differential action on the ropes. It is, therefore, probable that it is the differential action that takes up or lets out the ropes, the take-up merely acting in a sense as an automatic adjustable idler. In tightening, when the rope stretches, or drys out, or even in running normal, the greatest pull will be near the take-up, but if the drive is exposed to moisture, and the rope shortens, it will be farthest from the take-up, depending proportionately on the number of grooves the take-up controls; so in large drives it is best to have more than one take-up.

If one should use an unyieldable substance, as, for experiment, a plain wire on two drums wrapped a number of times around and also over a take-up, and the drums were moved together or apart, we would find that the wire would have to slide around the drum; but, of course, with a rope in a groove it is different. The rope will yield some. It will also go deeper in the groove. This system costs more than the preceding form, owing to extra expense for the traveling take-up, but may be applied readily to different conditions, and will be quite satisfactory in general, if properly designed and installed.

The continuous-wrap system, having a take-up or tightener act directly on all the wraps, has practically none of the objectionable features mentioned in the other two forms, and is quick in action, making it applicable where power is suddenly thrown on or off. If the tightener is made automatic, it may be controlled in numerous ways, as with a weight or weight and lever or tackle blocks and weight, etc. It also may be fitted with a cylinder and piston, with a valve to prevent too quick action, if power is suddenly thrown off or on. There is ordinarily practically no unequal strain on the rope. This system may be applied to different conditions as readily as the preceding form. Its cost is more than that of either of the others, as the tightener must have as many grooves as there are wraps. It must also have a winder to return the last wrap to the first groove, and to give its highest efficiency, it must be properly designed and installed. In either of the continuous-wrap systems, if a portion of larger rope is used, it will produce a greater strain directly behind the large rope, owing to its traveling around the sheave quicker. In angle work there is always extra wear on the rope in the side of the groove, as only the center or one rope may be accurately lined; so it is not advisable to crowd the centers in angular drives, as the shorter the centers and wider the sheaves the greater the wearing angle. It must be remembered that the foregoing applies to ordinary simple drives as shown in the sketches; where the drive is complicated, it may be necessary to make other allowances.

Good material should be used and competent parties employed for designing and installing rope drives. Don't be hasty to condemn a drive in general because of a poor rope, a flaw in a sheave, or because of its being erected in an unworkmanlike manner.

Free Art Importations and Manufactures

Many of our readers are aware probably that the prominent artists of the country are practically unanimous in seeking to have the import duty removed from paintings and other works of art which may be imported from other countries. At present a special effort is being made to educate public opinion in this matter, and the American Free Art League has been organized, whose headquarters are at 50 State street, Boston. The secretary of this league, Myron E. Pierce, calls our attention to the fact that the free importation of art objects will have a beneficial effect upon our manufacturing industries, or at least very many of them, especially those in which it is desired to build up an export trade, and in which the product will come into competition with the products of foreign manufacturers, designed and made largely by what are known as artist artisans. Mr. Pierce says:

The removal of the duty on works of art would not in any way infringe upon the domain of the protective system. It would, however, aid our manufactures in a way in which they most need assistance today.

We are now extending our markets to other countries where we are entering a competition in which the margin between success and failure is oftentimes very small. In such a competition the question of good design in the manufactured articles may very often be the deciding factor between success and failure. Even in our own markets, foreign fancy novelties in silks, woolens, and cottons, and other commodities in which the design plays an important part, compete successfully with our manufactures chiefly because of the fact that the tones are softer and the designs better. The best domestic concerns employ designers who are either foreigners or who have received their education abroad.

This is a state of affairs which the creation of an art atmosphere in America would remedy. If the Government does not wish to undertake the active encouragement of our industries in this respect by appropriations for art education, it can at least cease its narrow policy of taxation and suppression, and allow the growing impulse and taste of the people to develop and express itself freely and unhampered. It can allow the art treasures of the Old World to come in here without molestation. Their introduction would encourage and stimulate our designers, and they would soon be surrounded by many examples of good art, an artistic environment would be provided for them, and they would be enabled to acquire skill and good taste in design without going abroad. The design in our manufactured goods would soon feel the effect of such an art education, and America would no longer be handicapped in this respect.

Germany has grasped this great truth that the design of objects of manufacture may often be the deciding factor in their sale under the modern conditions of keen competition. She made a scientific study of what was necessary to enable her manufacturers to compete with the world. The result of that investigation brought out the word "education" very clearly. Germany lost no time in founding technical schools which proved the correctness of her diagnosis. They have revolutionized the industries of Germany. The second stage of the German government's task in building up German industries has been the erection of art museums, where her designers might acquire skill and good taste from the study of the best examples of art. The government has spent millions of marks in building the great new museum of Berlin alone.

It will not do for our Government to adopt a less progressive policy, if we are to compete in the world's markets; much less can we afford to continue the present policy of discouragement to American artists and designers. Let protectionists and free traders unite in securing this most salutary legislation.

The writer of this, as a small boy, used to make tubing by coating paper with paste and coiling it around a wooden mandrel. A similar process is actually used for making gas pipes, the paper of a width equal to the length of the desired pipe, being coiled in melted asphalt around an iron rod; strong pressure is applied, the exterior is then covered with sand and the pipe cooled, and a waterproof coating applied to the outside.

AMERICAN MACHINIST

Issued Weekly by the

Hill Publishing Company

505 Pearl Street, New York.

Also Published at 6 Bouverie Street, London, E. C.

Correspondence on mechanical subjects solicited and paid for. Name and address must always be given—not necessarily for publication.

Address all business communications to the American Machinist, 505 Pearl Street, New York. Matter for reading columns may be addressed to the Editor.

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Subscription price $4 per year, postage prepaid, to any post office in North America; $5 in all foreign countries except Europe and British possessions in Eastern Hemisphere.

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During 1905 *the* AMERICAN MACHINIST *printed and circulated* 1,059,100 *copies, an average of* 20,367 *per issue. Of this issue* 17,750 *copies are printed. None sent regularly free. None taken back from newsstands. No back numbers beyond current year.*

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Some Demands of the Tool-Steel Business

Much is being made nowadays of improved and especially more precise methods of hardening and tempering steel tools. We have our improved pyrometers, and other means of accurately determining the temperature at which pieces of steel are heated, and gas-tempering furnaces, in which a temperature, once attained, is accurately maintained. These are very good as far as they go and remove some causes of trouble; but there are large users of steel who are convinced that a stage of progress has now been reached when there is a demand for considerable improvement in the methods of the steel maker. These methods are believed to be nowhere near the degree of refinement that has of late been introduced in tempering and hardening processes. The carbon and other contents or constituents of tool steels are often little better than guessed at by the maker, and in the subsequent treatment, especially that of hammering, the matter of proper heat and of the general avoidance of treatment which is known to be injurious to a bar of steel, needs revision. A large user of steel who took his various foremen on an excursion to certain steel works, returned with a more or less demoralized force. They were convinced from what they had seen that it was a miracle if they ever got any satisfactory results from hardening and tempering operations, and that many of the difficulties they had been encountering in their work were absolutely unavoidable and unpreventable until considerably greater pains should be taken in the making of the material with which they had to deal. They saw bars of steel heated to a temperature which they had been taught to carefully avoid. They saw steel worked under the steam hammer at a temperature lower than they would themselves dare to handle it. In short, they saw many things done in these steel works which the makers of the steel had repeatedly cautioned users against doing, and which they had been educated to believe were ruinous to steel. No doubt some steel makers are careful regarding these matters and have, in times gone by, perhaps been fully up to the standard required of them. But the standard is changing; it is being moved to higher ground by the requirements imposed upon modern steel and modern metal-working machinery, reinforced by improved and much more precise methods of hardening and tempering, by which much greater uniformity in those operations is secured. The time seems to have arrived when the steel makers should introduce some of the refinements for heating and for measuring heat which are now so generally employed by large users of steel in hardening and tempering.

The Remainder of the Iron-Ore Supply

The one considerable supply of ore remaining outside the control of the U. S. Steel Corporation having been now acquired, it is obvious that this great trust has placed itself practically in absolute control of the steel business and in a position to fix prices for steel with little regard for any other consideration except the necessities of consumers. In other words it can charge "all the traffic will bear."

A number of our trade contemporaries comment upon the gigantic deal by which the Hill ore properties pass into the hands of the steel trust and we are given an array of figures as to prices to be paid as royalties, for transportation, etc., all of which mean that the steel corporation sees its way clear to recouping itself for higher costs, and an immense profit besides, by means of its control of the supply of raw materials.

The steel trust will, of course, do just what the lead trust has done. The supply of raw material for lead making is closely controlled by the American Smelting and Refining Company, which has upon occasion demonstrated its ability to compel lead consumers to pay prices for lead far above what normal market conditions would sustain.

Undoubtedly the steel trust will sooner or later do the same thing and then it will perhaps be made plain to many who do not now understand it, just what the difference is between so called trusts and real, genuine trusts; or rather, between mere large aggregations of business and real monopolies.

When a business organization controls the supply of raw materials for a given industry, which it may do in several different ways, then it controls the business and is a monopoly.

It being obvious that such a monopoly has been obtained by the U. S. Steel Corporation, it is but natural that steel users, especially those who are now, or in the future, may be dependent more or less upon foreign business, should consider what this may mean to them. It is plain that, so far as foreign business is concerned, it will handicap them still more; for in foreign markets they must compete with English steel made from free ore or with Belgian or German steel made from ore much nearer free than our present tariff schedule allows it to be here.

As to home trade many may think that prices will adjust themselves to a compensating basis and so they will to a certain extent, but there can, of course, be no doubt that anything which tends to establish and maintain higher costs will result in a tendency to restrict production and curtail business.

NEW TOOLS AND MACHINE SHOP APPLIANCES

A 36-INCH LATHE.

The lathe shown in Fig. 1 is the first of a new line of heavy lathes being brought out. It swings 36 inches over the bed and is made any length up to 36 feet. The spindle has a 3-inch hole through it,

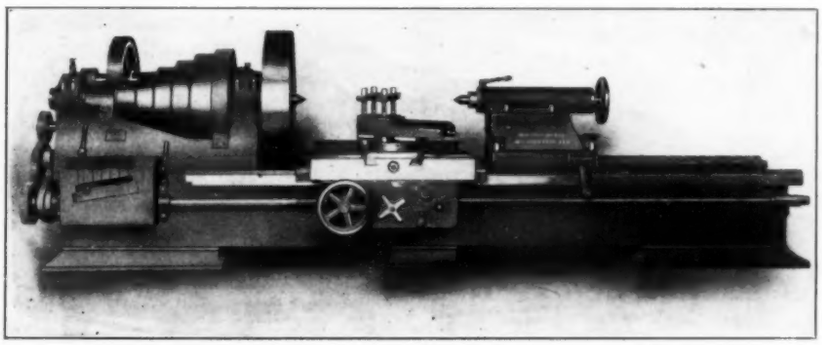

FIG. 1. A 36-INCH LATHE

the front bearing being 6⅞ inches diameter by 11 inches long. The thrust of the spindle is taken on bronze and tool-steel rings hardened and ground.

With a single-speeded counter-shaft ten spindle speeds in geometrical progression are obtained ranging from 3 to 350 revolutions per minute. The ratio of the back gearing is 15 to 1.

In addition to the usual range of screw threads spirals of 1 turn in 1 inch to 1 turn in 12 inches may be cut by throwing in the back gears and shifting the feed gear by means of the handle in front of the headstock.

The half tone Fig. 2 and the line cut Fig. 3 show the change-gear box. The gears in this box are of steel, and permit of seven changes of feed without changing the gears on the spindle and screw. The pinion *B* is mounted on a sleeve *C* and is thrown into or out of mesh by the eccentric lever *D* shown to the right in Fig. 3. *B* is moved into position to engage with any of the gears *E* by means of the handle shown projecting from the slot in the change-gear box in Fig. 1. The gear *F* is secured to the stub *G* and transmits motion from *G* through *F* and *A* to the sliding gear *B* and thence to any of the gears *E* keyed to the lead screw *H*. By engaging the clutch shown in Fig. 2 the drive is direct from stub to lead screw.

The apron is of the double-wall pattern shown in Fig. 4. This permits all the gear shafts to be supported in bearings at both ends, obviating the objectionable over-hang found in aprons having but one wall. When either the cross or longitudinal feed is in, the lead-screw nut is automatically locked open, and *vice versa*. The feeds are obtained through the change-gear box and are equal to four times the number of threads given on the index plate for a given position of the lever.

Fig. 5 shows the feed pinions and the clutch shaft for operating them.

The taper attachment is fastened to the rear of the carriage. It will turn tapers up to 4 inches per foot 24 inches long. It is graduated both in inches per foot and degrees.

The tail stock has a pawl which engages a rack cast solid with the bed; this makes slipping under heavy strain impossible. The lathe is also made with a triple-geared head giving a ratio of 50 to 1.

This lathe is made by the New Haven Manufacturing Company, New Haven, Conn.

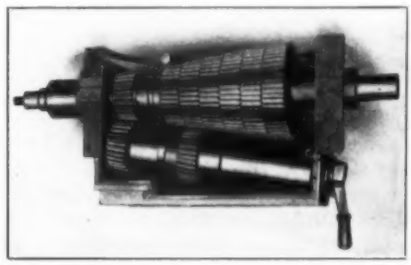

FIG. 2. THE CHANGE-GEAR BOX

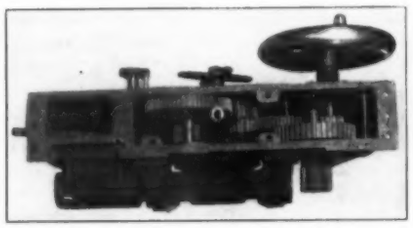

FIG. 4. SHOWING DOUBLE WALL CONSTRUCTION OF APRON

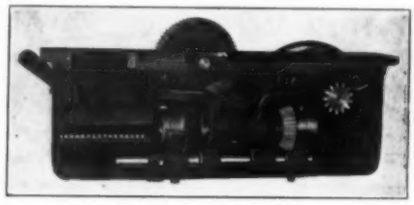

FIG. 5. SHOWING FEED PINIONS

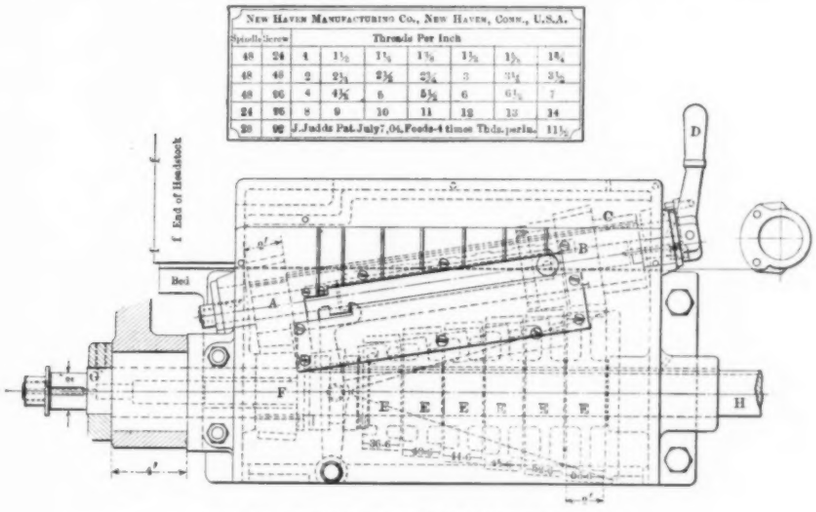

FIG. 3. DETAILS OF THE CHANGE-GEAR BOX

A. E. Hoermann, 41 Park Row, New York, has recently placed a sand-blast apparatus on the market which uses a small nozzle and high pressure. The device takes the air from the shop system. It is stated that better work is done by it than by the machine using air at 15 to 30 lb. pressure, and that it is equally economical.

The Eiffel tower, erected for the Paris Exposition of 1889, and which will become the property of the city, January 1, 1910, has had its term of life extended from this rate to 1905.

FIFTH ANNUAL CONVENTION NATIONAL MACHINE TOOL BUILDERS' ASSOCIATION

The fifth annual convention of the above named association met at the Hotel Breslin, New York City, October 9 and 10 and there was a good attendance. As is usual at the meetings the different sessions were largely taken up with routine business.

Among the subjects coming up for discussion before the convention was apprenticeship systems. A paper was read on this topic by E. P. Bullard, Jr., and afterward thoroughly discussed by different members.

DISCUSSION OF SYSTEMS OF COST KEEPING

The first thing on the program for Tuesday afternoon was a discussion of systems of cost keeping. Fred. A. Geier, of the Cincinnati Milling Machine Company, as chairman of a committee appointed by the association to consider this subject, introduced Mr. Gunn, of Gunn, Richards & Co., an expert in the matter of cost keeping. Mr. Gunn addressed the association briefly, not to tell them how they should keep their cost accounts, but to emphasize the importance of having a uniform basis upon which to compute cost accounts. He alluded to the vital difference between physical deterioration of machine tools and equipment, and what is called antiquation; that is to say, a lessening of value due to the approach of a time when it will no longer pay to use a tool, though it is yet in good physical condition. While he confessed that this must, in the nature of the case, be a charge which must be largely guessed at, yet the important thing for the members of such an association, or for people engaged in the same line of business was to have a uniform rule regarding this matter, so there might be intelligent, rather than unintelligent competition.

Again, in the matter of charging as a part of costs interest on capital invested, he said that some members of the association were in the habit of charging—say 6 per cent. on such capital, while others believed that no charge should be made for this. As for himself, the speaker did not believe that interest on capital was properly an element of cost, but that is not, he thought, the main thing; the main thing being that manufacturers engaged in the same line of business and competing with each other should have a common understanding as to whether it is a proper element of cost, or whether it is not, and having determined that point, all should agree to be guided by it; and so with every other element of cost.

Mr. Gunn evinced a thorough command of the subject, and his address was listened to with marked attention. At its close, Mr. Geier addressed the members, reinforcing the points brought out by Mr. Gunn, stating that he had already secured an agreement to a uniform basis of cost accounting in an association somewhat analogous to the Tool Builders, and Mr. Geier advocated the appointment of a committee composed of members of the association, or the employment of experts, to carefully consider this subject, to gather necessary information from the members, and to formulate a rule, so to speak, according to which all members could and would be expected to compute their costs, so that unintelligent competition might be eliminated. Mr. Geier called attention to the fact that in recent years the elements of cost had changed considerably, and therefore the method upon which they should be computed had also changed. He expressed the belief that it now required a larger investment of capital, for the transaction of a given volume of business than was the case in former years, and he believed that a good many manufacturers were deceiving themselves by not making allowance for this fact. He believed that it would be possible to arrange a formula, so to speak, for the computation of costs, which would apply to any machine-tool establishment, and he hoped that the association would take steps which would lead to the adoption of such a formula, and to the securing of uniform action upon it, not, of course, with a view to controlling selling prices at all, but simply to enable the members to know what their product costs, and to have those costs based upon the same elements in every establishment. Mr. Rivett, of Boston, and others, also discussed the subject.

THE LUNCHEON AND EXCURSION

On Tuesday, the 9th, the delegates and visitors were tendered a luncheon at the Hotel Imperial by the AMERICAN MACHINIST, and on Wednesday an excursion to West Point was given by *Machinery*, the trip being made by boat.

The next convention will be held in the spring and very likely at some point in the vicinity of Jamestown, Virginia, owing to the exposition which opens there at that time.

ELECTION OF OFFICERS

The voting for officers for the coming year, resulted in the re-election of President E. M. Woodward, of the Woodward & Powell Planer Company, Worcester, Mass., Secretary P. E. Montanus, Springfield Machine Tool Company, Springfield, Ohio, and First Vice-President William Lodge, Lodge & Shipley Company, Cincinnati, Ohio; F. E. Reed, of the F. E. Reed Company, Worcester, Mass., was elected second vice-president; and W. P. Davis, of the W. P. Davis Machine Company, Rochester, N. Y., treasurer.

Echoes from the Oil Country—Cast Iron-Beams—Hunting Information and Recreation—Theoretical Knowledge and its Practical Application

I had not the least idea that such a subject as cast-iron beams could be as interesting as I find it to be. Following it up is much like strolling through the woods in this section of the country. Now you are in a little clearing and everything is serene and the going is good. The next minute it is thicket and briers and brakes and vines and you won't know where you are, or which way to go to get out. The top of the hill gives a clear view of the place at which you wish to arrive but the intervening pitfalls are hidden. There is a good road leading away from the hill, and "all roads lead everywhere if you make the right turns," but the forks, branches and blind trails are very numerous. Oh, yes, there are sign boards; they tell where some of the other places are, but never tell you where you are, and the geography cannot afford to get down to minutiæ.

Unless you really have to get somewhere as part of your day's work, this kind of strolling is interesting enough. The compensation is found by the way. A new variety of brier may hold just as tightly and leave as painful a scratch as a common and familiar one, but is interesting because new. The promising path may lead you out of the way but has compensations while you are discovering where it does really lead. Even the sore spots you accumulate on your anatomy may be in places that never were sore before, and that is worth something to some people.

This may not be very explicit as yet, but it is just such a time that I have been having with this subject. I have had a very pleasant time indeed. I have associated with the man who never went on an exploring trip for the fun of exploring. When he moved at all it was because he had to go somewhere. He had a guide who took him over the orthodox road. He didn't get a scratch, or fall, or see a snake, and he didn't want to. He never doubted the road, or the guide, and—well, his opinion of me is not always flattering.

PICKING UP INFORMATION ABOUT CAST-IRON BEAMS.

Perhaps a brief description of my own wanderings on this excursion may interest some; it has been quite a vacation to me. I shall not attempt to give these views in the order that I stumbled on to them.

A cast-iron beam will break when the uttermost fiber under tension is strained to the tensile strength of that piece of cast iron. That is to say: The moment of resistance equals the tensile strength multiplied by the moment of inertia divided by the distance from the neutral axis to the outermost fiber that is under tension ($M = S\frac{I}{c}$). This is following Reuleaux, as pointed out by a friend, and says that my irregular section will break the weak way at about 370 pounds. Knowing, from information received from various sources, that text- and hand-books are for the use of those already educated in the subject (this is one of the mudholes that I fell into), I had the interpreting done by an expert and the result is his. He took 20,000 pounds as a fair tensile strength.

Transverse, and not tensile, strength should be used for S. This is following the International Correspondence Schools. They give this at 36,000 pounds in one place, and 38,000 in another. By using the latter that beam should break at about 700 pounds.

TENSILE STRENGTH—SOME SURPRISING FIGURES

The information is given by another, and Thurston is named as the authority, that this value is sometimes as high as 62,000 pounds. Using that the beam should break at about 1140 pounds.

On the authority of Kent, by testing a rectangular beam 1 inch square and 12 inches between supports we find it will bear 1/18 of the strength which is to be used in figuring. Assuming that my friend who follows Reuleaux is right, this would be the tensile strength of the specimen and when our test bar breaks at 3200 pounds we are getting iron that has a tensile strength bordering on 57,500 pounds. Also is it not a fair assumption that if a bar with 20,000 pounds tensile strength should break at 370 pounds, as figured, one that does break at 1100 pounds has a tensile strength of 59,000 pounds?

This value that is called by some transverse strength, and is entirely ignored by others, is said to be found by breaking a lot of specimens and noting the results, and is not the result of mathematical deductions founded on tensile and compressive strengths.

Owing to the peculiarities of testing machines and of cast iron, neither the real tensile nor compressive strengths are known with any degree of accuracy.

ELASTIC LIMIT RATHER THAN BREAKING STRENGTH

After acquiring information about all of the above I find that I have been going in entirely the wrong direction and that it is the elastic limit that the safe, sane and correct computation should be based on.

Brachistochrone quotes Church as giving 9000 pounds for tension and 18,000 pounds for compression as the elastic limits, and 6000 pounds as the safe load for tension and 12,000 pounds for compression. He also quotes Reuleaux as follows: "The limit of elasticity in a deflected beam, both on the tension and compression sides, will be reached when their respective stresses S become equal to the modulus of resistance." He then explains that " by modulus of resistance is meant the elastic limits for tension and compression respectively."

This is indeed very clear and cannot be gainsaid by anyone. The elastic limit in a deflected beam, both on the tension and the compression sides will be reached when you put on stresses enough to get to them, or in other words you will get to the limit of elasticity when you get to the elastic limit.

While Church gives an elastic limit it is hard to believe that all cast iron has the same elastic limit, and that test bars that break at 3200 pounds are not stronger that those that break at 1900 pounds.

Unwin seems to put a barrier across that lane also, as follows: "Cast iron has properly no elastic limit," and a number of others have said the same thing either plainly or in hints. Perhaps that is true; but I am sure that it has a breaking point, which I often want to know only that I may avoid it.

THE VOGUE OF GRAY IRON

But there is a bright side to all of this, for I am informed that cast iron is never used where its strength has to be considered. Perhaps if the maker of our shaper had known that, the teeth of the gears would not have stripped as they did. I believe that lots of people take this view of the matter. It is hard to account for some of the things that are made otherwise.

One designer, for whom I have the greatest respect, and whose designs have been put to the severest tests and have been proven of high merit, frankly told me that he did very little figuring on dimensions of parts made of cast iron, but guessed at them, basing his guess on former experience with the same or similar parts and his knowledge of the iron to be used.

The world has been moving when I did not, in my little corner, realize it. Incidentally I have learned that cast iron is being so rapidly supplanted that it is only a question of time, and a very short time at that, before it will not be used in the finished article. In support of this I was told the case of a company that erected a large foundry with the intention of making gray-iron castings, and when it was completed they found that there was so little demand for such castings that they were obliged to turn it into a steel-casting foundry. Between the steel-casting people and the malleable-iron people, and the people who make something that can be sold for either, "treacherous," "irregular," "unreliable," "weak" cast iron is as good as driven out of respectable mechanical society, perhaps.

I still thought that machine tools, and engines, and punches, and presses, and boiler fronts and grate bars, and stoves, and dynamos and motors, and pumps, and the few million or more other things that used to take some gray iron, were still doing it, even if I had not heard much lately of the fellows who make cast-iron scissors and razors, and if the one who used to make his lathe tools of it has got reversed by the high-speed steel.

THERE IS CAST IRON AND CAST IRON

It is easy to break test bars and note the breaking load and the deflection, and it is not hard to note the relative shrink of the bars. If uniformity can be obtained in them, it would seem that the safe working stress would also be uniform, although it might not be safe to assume that the bar that broke at the highest load would safely bear the highest working load. From my experiences as partly outlined in the foregoing, I am inclined to trust to the conclusions drawn from the test bars rather than to take the general conclusions of someone else, drawn from I know not what, and applied in a way I cannot logically follow.

I admire Entropy for sticking up for his friends, the books; they are also my friends, and I love them in spite of their shortcomings, and in spite of my own (which are more and worse than theirs), but I do not think he does justice to cast iron. Besides the variations due to practices in the foundry, which may cause castings to differ, there are even more serious ones. I have great respect for the molder and the results which he gets, in spite of the growling I do about his sins of commission and omission, in the hope of having him do still better. Think of a boss molder using several kinds of pig and perhaps 40 per cent. of scrap of an unknown mixture and still holding his test bars within a couple of hundred pounds of being uniform. With proper material and proper appliances for using it the molder can, and does, show that, in spite of the despair of the college professor and his students, cast iron, because of its range and the variations that can be gotten by its intelligent use, is our most valuable metal; it is so because of, and not in spite of, this same ability to do the unexpected.

I think it was Entropy that built a house by sections some time ago, and I wonder if he used all sorts of lumber—pine, hemlock, oak, basswood, cherry, maple, poplar, ash and the others; used it, whether heart wood or sap, shaky or sound, knotty or clear, and put it on without regard to the way the grain ran or to the way the strains came, or what they were likely to be? It is all wood, just as all cast iron is cast iron. In planting his little orchard (I surmise that he has an orchard by this

time), I do not suppose that in ordering he only called for fruit trees and would expect to get the same thing, whether they sent plums, apples or quinces. Even with apples some are sour and some sweet.

With carefully selected material, intelligently used, I do not think that cast iron is any more variable in its action than steel of a corresponding grade, nor than wrought iron even, and the latter has often been held up as a paragon in that respect. When I say of the same grade, I mean that steel worth several cents a pound should not be compared with cast iron. Compare bessemer steel with it and I do not think it need be ashamed of the comparison, or take the old merchant bar iron that used to be full of all sorts of seams and hard spots.

One of the reasons for the irregularities of cast iron lies in the matter of cost. Care costs money. If a man wants potatoes all of one size and shape, he might be able to get them, but not at a dollar a bushel, even if the regular price was only 50 cents.

SOME MORE RESULTS OF TESTS

Referring to the last paragraph in the article under the head of "Cast-Iron Beams" at pages 385 and 386 by Peter Palmer, in which he asks if the test bars were tested so that the tensile strength can be given I would state that these bars were not so tested. I have before me a record of tests of some bars of different section, and while they do not have any bearing on the question of the applicability of the formula to beams of irregular section it appears to me that they may have some bearing on the question of correctness of the formulas themselves.

These bars, three in number, were 2 inches x 1 inch in section and were broken 24 inches between supports. Two inches was the width and 1 inch the depth.

Applying the usual formula, and using 20,000 pounds as the ultimate stress, these bars should have broken at about 1100 pounds or if 25,000 pounds is used, which, as he says, would be a good tensile strength for cast iron, they should have broken at a little under 1400 pounds. They did break at 2650 pounds, 2650 pounds and 2200 pounds. Running back through the formula would seem to indicate that the first two bars had a tensile strength of nearly 48,000 pounds, and the last one of nearly 40,000 pounds.

Tested for tensile strength they showed 20,600 pounds, 19,500 pounds and 15,700 pounds. These were not our regular sizes for test bars but were made for a customer who wanted to have them tested. Our regular bars are 1 inch x 1 inch, span 12 inches between supports. Those taken from the same mixture as used in the first two mentioned above break at about 2600 pounds, indicating by the formula a tensile strength of nearly 47,000 pounds. We have had bars that stood over 3200 pounds, but never thought that they would have a tensile strength of anything like 57,000 pounds.

Judging from my own experience it would seem that if the breaking load is taken as the starting point and the formula is used to find a value for the ultimate stress, and to that is applied the ratio 10: 4 as figured stress is to tensile strength, that the truth is not far off. If the tensile strength is the starting point multiply it by 2.5 to get the proper value of S. Better yet if you have a machine for both breaking and tensile tests within reach have some tests made and find the correct relation in your own iron between the transverse and the tensile strengths.

THE ART OF MAKING PRACTICAL APPLICATIONS OF THEORETICAL KNOWLEDGE

There is just one other idea that this discussion has brought out, and that is the one that there is no royal road to knowledge. As applied to the work of the world this is apt to leave an erroneous impression. The art of knowledge is always useful even if stripped of all theory, but is limited in its application. More than that the art should be taught first as being the most important to the average man. To illustrate my meaning I will tell of my own experience with logarithms. I had heard that they were useful in reducing the difficulties of mathematics and I started in to learn how to use them. My text-book was an encyclopedia, and there were pages devoted to the subject. To practice with I had a table in Trautwine's hand-book. Practical results, nothing or less. I tried another encyclopedia with the same result. Several years ago F. A. Halsey furnished three short articles to the AMERICAN MACHINIST on the subject. He took a section of a table of logarithms from Kent and showed how to work them. That was the art of knowledge as applied to that subject. If he said one word about the theory of the subject, or of explanation as to how the tables were derived I have no recollection of it. I used them constantly up to the time when I became acquainted with the slide rule, but I have never had any curiosity beyond the proper use of them. When any doubts arose I have solved them by working out the example in the regular way and following step by step until I found wherein my practice was wrong if it was.

My advice to the practical man is to use every short cut to knowledge that you can and when you get mixed up in your practice of it do not be afraid to still keep whacking away. Even the theoretically educated man gets mixed up in practical things once in a while. You will always find friends who can and will help you out, just as they have been lending me a helping hand in this case of cast-iron beams.

W. OSBORNE.

Obituary

Giles Beach died at his home in Gloversville, N. Y., September 9, 80 years old. His life work was the design and construction of church organs, which he followed for 60 years. He was an associate member of the A.S.M.E., and one of those who took part in the visit of the society to Europe in 1889.

The Engineers' Society of Western Pennsylvania

This association will have an excursion to the Carnegie technical schools, Pittsburg, Saturday afternoon, October 20. It will also, on Saturday, October 27, have an all-day excursion to Conneaut harbor, Ohio, going by special train on the Bessemer Railroad. A nominal charge will be made to members for the latter trip, as it will be necessary to provide for a lunch on the train.

The regular monthly meeting of the structural section will be held at the society's rooms, Fulton building, Pittsburg, October 23, at 8 p.m. A paper will be presented, entitled "Tests of Bricks," by Jos. A. Shinn.

The regular monthly meeting of the mechanical section will be held November 6, at 8 p.m. The paper of the evening will be "Report of Some Pitometer Investigations," by J. D. Underwood.

Business Items

The New York office of the Whitman & Barnes Manufacturing Company, Chicago, has been moved from 111 Chambers street to 59 Centre street.

The Japanese Imperial Government has placed an order with the Reeves Pulley Company, Columbus, Ind., for "The Reeves" Transmission for use on machine tools at the Osaka arsenal.

The firm of Maris Brothers, Philadelphia, consisting of Frank Maris, Charles E. Maris and M. B. M. Tatum, was dissolved by mutual consent under date of Oct. 1, 1906. The firm of Maris Brothers will be continued by Frank Maris and Charles E. Maris.

The Star Corundum Wheel Company, Ltd., Detroit, Mich., has just closed contracts for a new factory building, which will be located on Calvary avenue, Detroit, Mich., on the Wabash Railroad. The building will be 175 feet long by 70 feet wide, of reinforced concrete construction, and will be absolutely fire-proof. Power will be furnished by three-phase electric motors and the plant will be equipped with the most up-to-date machinery for the manufacture of abrasive wheels.

Manufacturers

The Ogden Iron Company, Jersey City, N. J., will erect a new factory.

S. W. Bryant, Centerville, Iowa, and others are erecting an ice plant.

The Hettinger Engine Company, Bridgeton, N. J., is building a new plant.

L. & J. A. Steward, tin-can manufacturers, Rutland, Vt., are erecting a new plant.

The Howells Mining Drill Company, Plymouth, Penn., will erect another addition.

The Aluminum Manufacturing Company, Two Rivers, Wis., will erect an additional factory.

R. Mansfeld & Sons, Louisville, Ky., manufacturers of office fixtures, will erect a new factory.

The Avondale Sash and Door Company, Chicago, Ill., will erect a new factory, to cost $12,000.

The Universal Caster and Foundry Company, Newark, N. J., will erect a five-story addition.

A new brass foundry is being built for the E. Stebbins Manufacturing Company, Brightwood, Mass.

The Page-Storms Drop Forge Company, Chicopee Falls, Mass., is considering plans for a new building.

The Amesbury (Mass.) Brass and Foundry Company has had plans drawn for a new foundry building.

The South Baltimore Steel Car and Foundry Company, Baltimore, Md., will make improvements at its plant.

A two-story addition will be built to the tool factory of the Irvington (N. J.) Manufacturing Company.

The Termaat & Monahan Company, Oshkosh, Wis., is contemplating an addition to its main machine shop.

The N. S. Sherman Machine and Iron Works, Oklahoma City, Oklahoma, will build a new machine shop.

Koehnline Bros., Wheeling, W. Va., are having plans made for extensive improvements to their ice plant.

Fire destroyed the barrel-hoop factory of J. M. Peet & Bro., Marysville, Ohio. Loss $20,000. It will be rebuilt.

The Benedict & Burnham Manufacturing Company, Waterbury, Conn., brass manufacturers, willl build an addition.

The Electric Heating and Manufacturing Company, Dolgeville, Cal., will shortly commence the erection of its plant.

James N. McCain, of Sharon, Penn., and others will erect a plant there for the manufacture of gas and gasolene engines.

William Sellers & Co., Inc., Philadelphia, Penn., building machine tools, has been granted a permit for a two-story addition.

The roundhouse of the Chicago Great Western Railway in West Red Wing, Minn., has been destroyed by fire. It will be rebuilt.

The Faultless Rubber Company, of Akron, Ohio, is erecting a plant of larger capacity in Ashland, to which place the company will remove.

Eddy Bros., Rutland, Vt., will build a new ice house, to be equipped with modern ice-harvesting machinery, including elevator and planer.

An addition to the crane-erecting shop of the Case Manufacturing Company, Columbus, Ohio, has been planned. It will cost about $10,000.

The Worcester (Mass.) Steel Foundry Company is building an addition to its Millbury plant, which will make room for four new furnaces.

The Tennessee Stave and Box Company, Memphis, Tenn., capitalized at $200,000, is having plans prepared for a plant to cost over $75,000.

It is reported that the largest factory in the country for the making of fine writing paper will be erected at Holyoke, Mass., and will form an extension of the American Writing Paper Company's property.

The Lloyd Manufacturing Company, Minneapolis, Minn., maker of automatic wire machines and wire goods, is erecting a large plant in Menominee, Mich., to which place the Minneapolis plant will be moved.

An appropriation of $500,000 for the enlargement of the plant of the Standard Steel Car Forge Company, New Castle, Pa., has been authorized.

Contract for the rebuilding of the powerhouse and water plant at Covington, Ind., recently destroyed by fire, has been let to Chas. A. Brown, of that place.

The Bryant Electric Company, Bridgeport, Conn., has awarded contract for the construction of a one-story addition, to be used as a plating and buffing shop.

Catalogs

Rogers Machine Tool Co., Alfred, N. Y. Circular illustrating and describing 32-inch swivel and turret head vertical boring and turning mill.

The Cincinnati Planer Co., Brighton Station, Cincinnati, Ohio. Catalog of variable-speed planers. Illustrated, 6x9 inches, 50 pages, paper.

Union Steam Pump Co., Battle Creek, Mich. Booklet descriptive of the Burnham Steam and power pumps. Illustrated, 4x5 inches, 48 pages, paper.

Northern Electrical Manufacturing Co., Madison, Wis. Bulletin No. 50A, describing spherical machines. Illustrated, 7x10 inches, 24 pages, paper.

The Barrett Machine Tool Co., Meadville, Pa. Catalog No. 6, describing horizontal cylinder boring machines. Illustrated, 8x10½ inches, 45 pages, paper.

Newhall Chain Forge and Iron Co., 9-15 Murray St., New York. Catalog No. 101, descriptive of hand-forged crane, block and hoisting chain. Illustrated, 6x9 inches, 12 pages, paper.

Whitney Electrical Instrument Co., Machado & Roller, Inc., general sales agents, 203 Broadway, New York. Catalog and price list of electrical measuring instruments. Illustrated, 4x8 inches, 36 pages, paper.

Ingersoll-Rand Co., 11 Broadway, N. Y. Catalog No. 45B, describing Ingersoll-Sergeant rock drills. This contains a list of 44 questions covering problems of rock drilling, tables and other useful information. Illustrated, 6x9 inches, 96 pages, paper.

Charles Englehard, 41 Cortlandt St., New York. Catalog describing Heraeus "Le Chatelier" pyrometer, containing a scale for the comparison of degrees Fahrenheit and Centigrade, tables of the melting and boiling points of various substances, etc. Illustrated, 6x9 inches, 34 pages, paper.

Warren Webster & Co., Camden, N. J. Part I, appendix VI, of general catalog, illustrating and describing "Star Vacuum" feed-water heater, purifier, filter and receiver. 6x9 inches, 32 pages, paper. Pamphlet, "Some Phases of the Feed-water Heater Problem," by Walter E. Harrington, which is a reprint of an article in the *Street Railway Journal* of July 22, 1905.

Quincy, Manchester, Sargeant Company, 114 Liberty street, New York. Catalog of Q and C metal-sawing machines, Pedrick & Ayer portable tools for the repair shop, pneumatic cranes and hoists, riveting machinery, etc. This catalog is arranged so that it can be a perpetual binder in which new sheets can be inserted as they come out. Illustrated, 6½x9½ inches, leather.

Miscellaneous Wants

Advertisements will be inserted under this head at 25 cents a line each insertion. Copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded.

Caliper cat. free. E. G. Smith, Columbia, Pa.

Cox Computers, 75 Broad St., New York.

Geo. M. Mayer, 1131 Monadnock Block, Chicago. Working drawings.

Will buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

Light, fine machry. to order; models and elec. work specialty. E. O. Chase, Newark, N. J.

Novelty in tool or machine specialty wanted. Particulars required. Box 202, AMER. MACH.

Special machinery designed and built. Walter S. McKinney, M. E., 43 Broadway, Flushing, N. Y.

Special machinery accurately built. Screw machine and turret-lathe work solicited. Robt. J. Emory & Co., Newark, N. J.

Wanted — Special screw-machine work up to 1 inch diameter; press work up to 5 inches diameter. Inventor's Mfg. Co., 134 Eliot St., Boston, Mass.

Work wanted for a Cleveland automatic lathe; handles 2 in. and under. The Earle Gear and Machine Co., 141 Oxford street, Philadelphia, Pa.

I can make your machine a success; solving mechanical problems is my specialty; wish improvement on present position. Box 170, AMERICAN MACHINIST.

We wish to hear from a party having a good hardware specialty to manufacture; something with an established market. We believe we can interest you. Wolverine Mfg. Co., Pittsburg, Pa.

A large English firm of machine-tool importers, having showrooms and offices in France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMERICAN MACHINIST.

Bids wanted to manufacture 30-pound patented article, in lots of 100, 1000 and 10,000. Materials, bar iron or steel. Punching, bending and drilling machinery only required. For blue prints, address Sauvage Safety Brake Co., 20 Broad St., New York.

Wanted to purchase—Working drawings of improved feeding devices used in connection with Dial power presses for assembling small metal articles, such as glove fasteners, buttons, etc. Correspondence with competent man in this line solicited. Box 203, AM. M.

The J. Geo. Leyner Eng. Wks. Co., of Littleton, Colo., are increasing their plant and are in need of good mechanics, machinists, blacksmiths and sheet-iron workers. Littleton is a suburb of Denver, where cost of living is reasonable; superb climate the year round. Address above.

Draftsmen, engineers, graduates—Join the Automobile Designing School and earn $30 to $60 a week. Positions waiting for you. Day and evening classes and by mail. New classes now starting. Write for prospectus. The Automobile Designing School, 1416 Broadway, New York City.

Tool catalog No. 22, 950 pages bound in cloth. Greatest small-tool catalog ever published. Will be sent post-paid on receipt of $1. Money paid for catalog refunded with first purchase amounting to $10 or over. Book costs you nothing if you become a customer. Montgomery & Co., 109 Fulton street, New York City.

We can build machinery for quick delivery. Having complete tool equipment, we wish to add to our present capacity for continuous output. Steam or gas engines preferred, or anything to be produced in a modern and up-to-date foundry and machine shop. Send drawings and specifications and we will give you estimate. United States Engine Co., Parkersburg, W. Va.

Be a draftsman making $150 monthly by taking individual instructions from chief draftsman of large concern, who will in a few months' home study equip you fully with complete drafting-room knowledge and practical experience to start you at $20 or $30 weekly salary and rapidly advancing. Furnish all tools free of charge, and a steady position when competent. Reasonable terms and success guaranteed. Write at once. Chief Draftsman, Division 4, Engineers Equipment Company, Inc., Chicago.

Business Opportunities

Treasurer wanted for large manufacturing company. Must invest in 7 per cent. paying dividend stock. Volume of business $360,000. Box 206, AMERICAN MACHINIST.

Machinery brokerage business can use good partner. Must invest. Old-established, excellent profits. Large assets, no liabilities. Box 207, AMERICAN MACHINIST.

Mechanical engineer wanted by large machine manufacturing business. Must invest in dividend-paying stock. Suitable salary. Box 208, AMERICAN MACHINIST.

Wanted—To correspond with parties desiring to develop and manufacture an invention

of merit connected with the automobile industry. Address H. O. Fletcher, Hyde Park, Mass.

I will purchase a substantial active interest in an established prosperous manufacturing concern desiring to extend its business and requiring an able, progressive partner. Box 247, Madison Square P. O., New York.

Wanted—Manufacturer to build and market, on royalty or other basis, a patented specialty in machine line, selling for about $500 at 60 per cent. profit. Necessity in steady demand. Novo, Box 216, AMER. MACHINIST.

Wanted to contract with shop within 50 miles of New York City, equipped for making highest-grade automobile chassis. Must have capacity for at least 100 cars per year and able to do highest-grade, interchangeable work, cheaply. No body work. Box 210, AMERICAN MACHINIST.

We can build machinery for quick delivery. A shop building machine tools wishes to take contracts for the construction of machinery or anything that can be produced in a foundry and machine shop. Send drawings and specifications and estimates will be made with guarantee of quick delivery. We can refer to a standard line of tools now on the market as to the quality of workmanship. Box 75, AMERICAN MACHINIST.

For Sale

For Sale—Foundry, wood and iron machine shop. Box 74, Albion, N. Y.

For Sale—Wood-patternmaking business in New York City. Box 146, AMER. MACHINIST.

All patterns, tools and jigs for my patternmaker's vise for $25. Also patterns for a small drill for $20. J. L. Gard, Denver, Colo.

Cleveland automatic lathe for sale, size 2 in.; has been used but little and is in excellent condition. Box 145, AMER. MACHINIST.

$50,000 buys plant, manufacturing own patented machines, in operation throughout the country, including patents, machinery, factory, tools, jigs, good will; 15 miles from New York City; doing good business. Box 958, AMERICAN MACHINIST.

Wants

Situations and help advertisements only inserted under this head. Rate 25 cents a line for each insertion. About six words make a line. No advertisements under two lines accepted, and no advertisements abbreviated. The cash and copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. Original letters of recommendation or other papers of value should not be enclosed to unknown correspondents. Only bona fide situation want or help want advertisements inserted under this heading. Agency advertisements must be placed under Miscellaneous Wants.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

CANADA.

Position wanted by man aged 35; has had 18 years' experience in machine shop, nine years of which time was on gasolene engines; have owned and operated shop and handled men for the past 13 years. Box 158, AM. M.

ILLINOIS.

Situation wanted—Superintendent or assistant; young man; technical education; practical experience, familiar with high-speed modern methods, tools, jigs, fixtures for rapid, accurate production of duplicate, interchangeable parts on small and medium size work; references. Box 220, AMERICAN MACHINIST.

MARYLAND.

Superintendent, good executive and business ability; expert mechanic; can make your plant pay; am now employed. Box 173, AMERICAN MACHINIST.

MASSACHUSETTS.

Technical man, tool and machine designer of eight years' experience would change. Box 224, AMERICAN MACHINIST.

First-class mechanical and freehand draftsman desires extra work during spare time. Box 198, AMERICAN MACHINIST.

Wanted—Situation as traveling salesman in any machinery or tool business; well experienced; references. Box 222, AMER. MACHH.

Wanted situation as employment agent for machinery or tool business. Thoroughly experienced in this line. References furnished. Box 223, AMERICAN MACHINIST.

NEW JERSEY.

Technical graduate, M. E., 26½, with six years' shop- and drawing-room experience in machine tools wishes responsible position. A1 references. Box 221, AMER. MACHINIST.

NEW YORK.

Mechanical draftsman wishes position; four years' experience. Box 227, AMER. MACH.

Mechanical draftsman, 4 years' experience, also shop experience, desires position in New York City or vicinity. Box 219, AMER. MACH.

Mechanical draftsman, 8 years' shop and office experience, desires change, specialty internal combustion engines. Box 211, AM. M.

Technical school graduate, five years' experience, wishes position with manufacturing engineering concern. Box 166, AMER. MACH.

General foreman—successful in producing first-class work at satisfactory cost, varied experience in building high-grade machinery, master mechanic—desires change; age 36; salary $36 a week. Box 196, AMER. MACH.

Situation wanted as foundry superintendent by man of ability and experience in all branches of the business; a practical mechanic and manager of men; 15 years' experience as foreman; 36 years old. Box 169, AMERICAN MACHINIST.

OHIO.

Superintendent, technical education, desires change. 20 years' experience engine pump and general machine. Wishes to locate with parties to build engines, triplex pumps, or automobiles. Box 214, AMER. MACHINIST.

PENNSYLVANIA.

Designing draftsman wishes to change; technical graduate; eight years' experience on gas engines and automobiles; practical and inventive man, familiar with modern manufacturing methods. Box 209, AMER. MACHINIST.

WASHINGTON.

Wanted—Machinist, with 10 years' experience, wants position as a beginner in drafting room; M. E. student of I. C. S.; Western States preferred. Box 200, AMER. MACH.

Help Wanted

Classification indicates present address of advertiser, nothing else.

CALIFORNIA.

Foreman for old established western gas-engine plant manufacturing stationary, marine and hoisting engines; must be a good organizer, able to handle men, up-to-date and able to show results; a man of experience, with good references; the right man can secure a permanent position with chance to advance soon; give full particulars. Box 121, AMERICAN MACHINIST.

CANADA.

Wanted — Experienced draftsmen on jigs, fixtures and tools; give age, experience and wages expected. Ross Rifle Co., Quebec, Canada.

Wanted—Toolmakers experienced on fixtures, dies and gages. Applicants should give age, experience and wages expected. Ross Rifle Co., Quebec, Canada.

CONNECTICUT.

Wanted—First-class operator on Jones & Lamson turret lathe; also one first-class all-around machinist. The New Machine Co., Danbury, Conn.

Wanted — Tool makers, die sinkers, drop forgers and men familiar with grinding machines. Apply to D. P. Beckwith, Pope Manufacturing Company, Hartford, Conn.

Inspector—Must be a thoroughly experienced good mechanic. An expert at gaging and examining manufactured small interchangeable machine parts for accurate and finish; capable of taking charge of inspecting staff. One with experience as inspector preferred. Apply giving full particulars of experience, etc., to Union Typewriter Company, Bridgeport, Conn.

ILLINOIS.

Mechanical draftsman wanted—A man with wide experience, thoroughly familiar with machinery drafting, and who has executive ability to take position as assistant of a large mechanical drafting department; prefer a man of college education; in answering, state age, experience and such other information as would be helpful in passing upon your application. Address all replies to Box 183, AMERICAN MACHINIST.

INDIANA.

Wanted—An up-to-date machine-shop foreman; one who has made a success and can give good references. Box 126, AMER. MACH.

Wanted—First-class tool makers and lathe men. Increasing business, manufacturing automobile motors. Address Western Motor Co., Logansport, Ind.

Wanted — Experienced engine erectors for permanent employment in one of the largest engine-manufacturing concerns in the country. Address Box 147, AMERICAN MACHINIST.

MASSACHUSETTS.

Inspector of jobbing work, gear specialist preferred; also one assistant shop manager. Gears, Box 215, AMERICAN MACHINIST.

Wanted—First-class outside erecting men familiar with steam engines. Location near Boston, Box 212, AMERICAN MACHINIST.

Wanted—Draftsmen and tracers on printing-press work; state age, experience and salary required. Address Box 197, AM. MACH.

Wanted—First-class machinists on automobile work. Apply to manager, Waltham Mfg. Co., makers of Orient automobiles, Waltham, Mass.

Wanted — First-class toolmakers, milling machine, floor and vise hands on high-grade medium weight machinery; good pay and permanent positions to competent workmen. Box 85, AMERICAN MACHINIST.

A growing machine shop, wishing to add to its line of work, invites correspondence with a man sufficiently expert in some profitable line (machine tools preferred) to introduce its manufacture, and later to attend to the sales and installation work. To such a man a liberal salary will be paid on demonstration of ability to make good. Box 98, AM. MACH.

MICHIGAN.

Wish to correspond with two draftsmen having experience of at least four years; must be familiar with boiler settings and general boiler work. Address "F. F.," Box 103, AMERICAN MACHINIST.

Wanted—Large manufacturing company located at Detroit have splendid opening for a young, capable, energetic electrical engineer; technical graduate with practical experience preferred; must have thorough knowledge of small, direct and alternating-current motors. Address Box 199, AMERICAN MACHINIST.

Wanted—A man capable of designing sawmill machinery and laying out complete installations. Must have experience of at least eight or ten years and be thoroughly practical. Address "G.," Box 102, AMER. MACH.

Wanted—Potter & Johnston machine hand; must be good mechanic and thoroughly understand the above machines and capable of getting good results from same. Address Continental Motor Mfg. Co., Muskegon, Mich. State wages wanted.

NEW JERSEY.

Wanted—Working foreman for small shop doing jobbing, mold work and building special machinery; give references and salary expected. Address "M," Box 201, AMER. MACH.

Several first-class tool and diemakers accustomed to high-grade work; steady employment and good wages to competent men. Sloan & Chace Mfg. Co., Sixth avenue and Thirteenth street, Newark, N. J.

We are increasing our tool-making department and solicit applications from toolmakers and machinists who are experienced on fine and complicated work. Apply to Victor Talking Machine Co., Camden, N. J.

We have increased our plant and desire floor and vise hands for day work and lathe hands for night work. Good pay and steady work to good men. Address or apply at Pond Machine Tool Co., Plainfield, N. J.

NEW YORK.

Two patternmakers wanted. Apply or write A. S. Cameron Steam Pump Works, 433 East Twenty-third St., New York.

Wanted—Experienced men on general tool work; steady positions for the right men. Remington Typewriter Factory, Ilion, N. Y.

Wanted — Experienced draftsmen, toolmakers and machinists. Give age, references and wages expected. Remington Arms Co., Ilion, N. Y.

Wanted, immediately, machinists; must be good lathe hands; applicants must give wages expected. Address "P. C. W.," Alsen, Greene Co., N. Y.

Wanted — Metal patternmaker and wood patternmaker on agricultural implement work; position permanent. Adriance, Platt & Co., Poughkeepsie, N. Y.

First-class pattern-maker wanted. Permanent position. Good town. Address with experience, wages wanted and references. Kerr Turbine Company, Wellsville, N. Y.

Wanted—An experienced foreman for switch department of large electrical works in New England; give full details, salary expected, experience, etc. P. O. Box 824, New York.

Wanted—A young man as draftsman, experienced on small tools and automatic machinery. Answer, stating experience and salary expected, "J. S.," Box 151, AM. MACH.

Wanted—Draftsmen capable of designing dies, jigs, fixtures and gages for the manufacture of light machine parts. Location, Central New York. Box 213, AMERICAN MACHINIST.

Wanted—Mechanical and electrical draftsmen. Apply, giving age, experience and salary expected, Engineer in Charge, Drafting De-

partment, General Electric Co., Schenectady, N. Y.

Wanted—Foreman for machine room in a small shop manufacturing automobile motors, etc.; good place for right man; state qualifications and wages expected. The Kirkham Motor Mfg. Co., Bath, N. Y.

A concern manufacturing light machinery desires a foreman for its automatic screw-machine department; executive ability and experience in this line are essential. Address Box 204, AMERICAN MACHINIST.

Mechanical draftsman, competent to design tools, jigs and fixtures for manufacturing small interchangeable parts; to receive attention state age, experience and wages expected. Draftsman, Box 226, AMERICAN MACHINIST.

Wanted — Chief draftsman, accurate, with executive ability and extensive experience in Webb printing-press designing; to a competent man we can offer a permanent position at a good salary. Apply Box 182, AM. MACH.

A traveling salesman, having practical machine-shop experience, to sell superior mechanical screw-machine accessories; good opportunity for proper person to advance; to receive attention, state age, experience and wages expected. Box 217, AMER. MACH.

Wanted—A salesman for machine tools; must be a thorough mechanic of good address and willing to travel most of the time, residing at or near Philadelphia; answer in hand-written letter, stating age, experience and qualifications. Box 184, AMER. MACH.

OHIO.

Wanted—Designers and detailers on heavy machine tool work; state age and experience. Box 218, AMERICAN MACHINIST.

Our growing business constantly requires additional machinists. We build lathes, planers, shapers, drilling machines; good opportunity for machinists. The American Tool Works Co., Cincinnati.

Wanted—A man of executive ability and long experience on universal grinders to take charge of grinding job in toolroom of a large manufacturing establishment in the middle West. Address Grinder, Box 192, AM. MACH.

Wanted—A young man to do detail work on gasolene engines; to one who is thoroughly familiar with this class of work, first-class wages will be paid; none but hustlers need apply. Address Box 178, AMERICAN MACH.

The National Metal Trades Association can place a few first-class toolmakers, patternmakers and blacksmiths. Positions will be guaranteed as steady and at highest prevailing rate of wages. This is an opportunity for first-class men to secure one of the N. M. T. A. certificates of recommendation. For further particulars address The National Metal Trades Association, Cincinnati, O.

Wanted—Superintendent of a large and growing factory, employing now about five hundred (500) hands, manufacturing high-class electrical product, wishes an assistant thoroughly up-to-date on quick interchangeable work at lowest cost; a man to become master mechanic in time; this is an excellent opportunity. Reply, giving age, whether married or single, past experience in detail. All letters acknowledged and held confidential. Box 205, AMERICAN MACHINIST.

Works manager wanted—A first-class man to manage the factory of an established and up-to-date manufacturing concern located in Ohio, employing about 500 men; must, in addition to having an extensive practical experience in modern shop methods, have sufficient technical education to handle the engineering problems that arise in foundry and machine-shop practice. Write, giving age, complete factory and technical experience and approximate salary required, Box 155, AM. M.

PENNSYLVANIA.

Wanted—Ten machinists, lathe, planer, boring mill and bench hands; steady work. Apply to Scottdale Foundry & Machine Co., Scottdale, Pa.

Draftsmen—A large firm of engine builders in western Pennsylvania wants draftsmen and tracers. State age, education, experience, and salary expected. J. A. M., Box 45, Pittsburg, Penn.

Machinist—Experienced in running double stroke headers. Good wages and permanent position to a first-class man. Metallic Specialty Mfg. Co., 1616-1628 North 21st St., Philadelphia, Penn.

Wanted—Foreman for boiler shop employing 75 to 125 men; one who can handle men to advantage and get out first-class work at a minimum cost; shop located in western Pennsylvania. Box 161, AMER. MACHINIST.

The Monotype Company maintains a free school for training young machinists to operate its type casting and composing machines. The demand for monotype operators is so great that it receives more applications for places in its school than can be filled. In making selections these qualifications carry most weight: Character, common sense, experience with automatic machinery (or) printing-office experience, or type-foundry experience. Full particulars will be furnished to inquirers who furnish full particulars about themselves. Lanston Monotype Machine Co., 1231 Callowhill St., Philadelphia, Pa.

RHODE ISLAND.

Wanted—A few mechanical draftsmen, men with shop experience preferred. State age, experience and salary expected. Box 225, AMERICAN MACHINIST.

Toolmakers wanted — First-class workmen on jig and fixture work for light high-grade machinery. Permanent employment to competent workmen. Appy to the Taft-Peirce Mfg. Co., Woonsocket, R. I.

WISCONSIN.

Wanted—A first-class machinist for the position of foreman; a hustler; no others need apply; good wages and steady work in a Wisconsin city. Box 156, AMER. MACH.

Machinists wanted to inspect and assemble automobile transmissions; experienced men desired, but men able to construct any good machinery will find desirable employment; open shop. Address Thomas B. Jeffery & Company, Kenosha, Wis.

Foundry superintendent is wanted for manufacturing company in middle West, melting 100 tons iron a day; a live up-to-date man is wanted, with experience on both large and small work; open shop; molding machines extensively used; beautiful small city. Address Box 153, AMERICAN MACHINIST.

Large concern building excavating and railway machinery wants to correspond with first-class mechanical draftsmen with view to filling future vacancies as they occur; wants men now employed; give full experience and reason for changing; shop experience great advantage; all letters acknowledged and held confidential. Box 919, AMERICAN MACHINIST.

WEST OF MISSISSIPPI.

Wanted—Competent foundry foreman, capable of making chilled cast iron and hard white iron; must give best references; interest in business for right man. Box 154, AMERICAN MACHINIST.

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THE NEW ENGINEERING BUILDING OF THE UNIVERSITY OF PENNSYLVANIA—I

$800,000 Home of the Departments of Mechanical, Electrical, Chemical and Civil Engineering—Its Plan and Equipment

The new engineering building of the University of Pennsylvania, in Philadelphia, is one of the most recent examples of a building designed for the instruction of students in engineering, and is attracting considerable attention; the formal dedication, on October 19, makes this an opportune time for presenting the following description.

FIG. 1. VIEW OF THE ENGINEERING BUILDING FROM THE SOUTHWEST

The building, of which a photographic view is given in Fig. 1, is the largest of the University group of seventy buildings, having a front 300 feet long and being 210 feet deep at the west end, 160 feet deep at the east end. It is situated at the northeast corner of the University's grounds; its eastern end is bounded by Thirty-third street, and its front faces a walk of the campus which is a continuation of Locust street. Its cost with equipment was approximately $800,000. It contains three stories, and under a portion of it is a basement, the space in which is also fully utilized. The building is of structural steel incased in concrete, with an exterior of dark brick with limestone trimmings, the general architectural treatment being in the English Georgian style. The total floor area is about 128,000 square feet. The heating is by direct steam, the exhaust from the engines being utilized for this purpose. The ventilation is by electrically driven blast fans located in the attic and in the basement, the ventilating system being divided into sections. The switches and controlling mechanism for the fan motors are placed in the various rooms of the building so that it is not necessary to leave the room to control the ventilation. While air is forced into the building in general, the opposite is the case for the toilet rooms, a very practical system being in use for their ventilation. Ducts are led to exhaust fans from the bowls of the water-closets, so that the rooms are practically odorless.

The building is virtually divided into two portions, the larger portion, which will be described in detail first, being that devoted to the needs of the students in mechanical, electrical and chemical engineering; the smaller portion, at the east end, is designed for the students in civil engineering.

THE BASEMENT

Fig. 2 is a plan of the basement. At the east and west ends are staircases leading to the main corridor above. At the southwest corner is a room containing the principal storage battery, particulars of which will be given in connection with the description of the electrical equipment. Next to the east of this are very nicely appointed lavatories, locker rooms and toilet rooms, the locker rooms containing numerous Merritt expanded-metal lockers, one being assigned to each student. In the middle of the building is the engine room, containing high-speed engines and direct-connected generators, supplied with steam by an underground pipe line from the main boiler plant of the University,

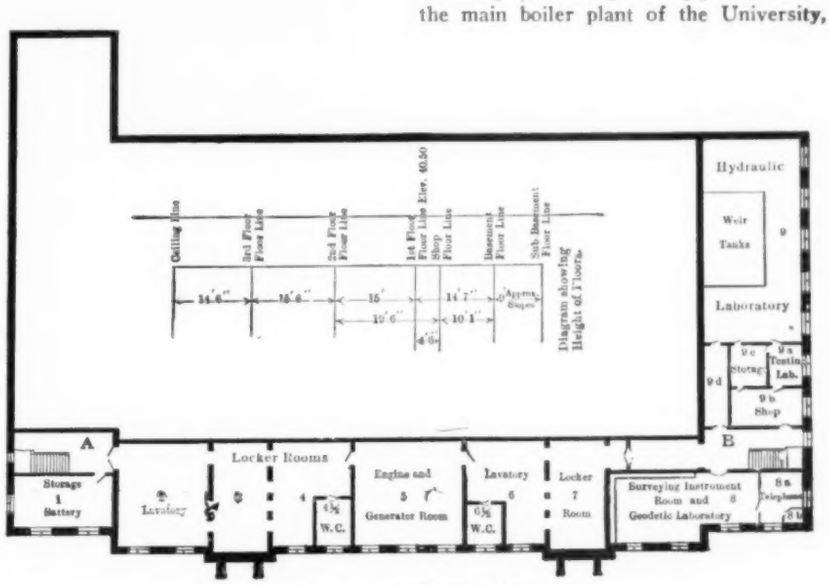


FIG. 2. BASEMENT PLAN

which is not far distant. The current used throughout the building, with exceptions, such as certain alternating currents used in the laboratory and generated there, is direct current with an electromotive force of 110 volts. To the east of the engine room are lavatory and locker-room accommodations for the civil-engineering students, and laboratories and shops of the same department, which will be described later.

THE MAIN FLOOR

Fig. 3 is a plan of the first or main floor. It will be seen that there are two entrances, one near the east end and one near the west end, the former leading direct to the mechanical-engineering department, and the latter to the civil engineering. There is, however, a spacious corridor running the full length of the building and terminating at each end in staircase shafts. This corridor, like a large portion of the remainder of the building, is wainscoted in light-colored marble and presents a very handsome appearance. The middle of the front or south side of the building is occupied by offices for the heads of the engineering departments and some of their assistants. The rooms in the front corners are laboratories, and back of the corridor, that is, north of it, but on a level about four feet lower, are the shops and most of the principal laboratories. The portion of the building along the east wall is occupied

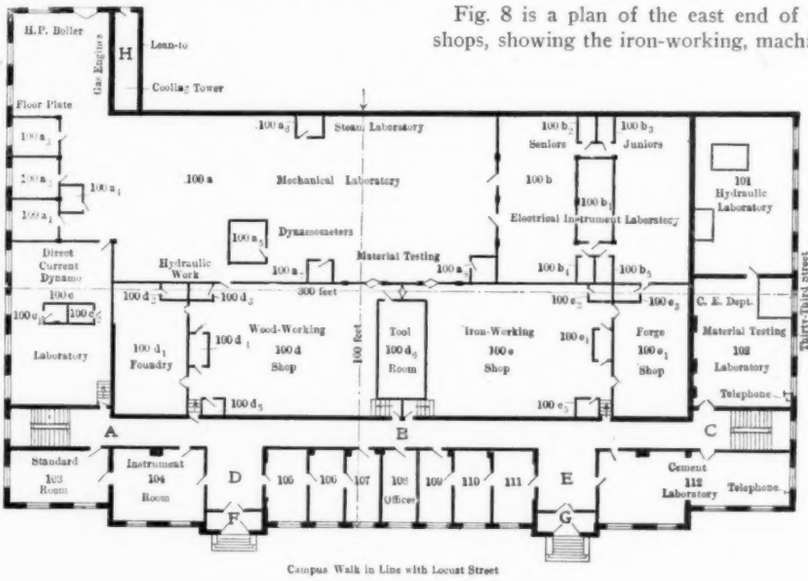


FIG. 3. FIRST FLOOR PLAN

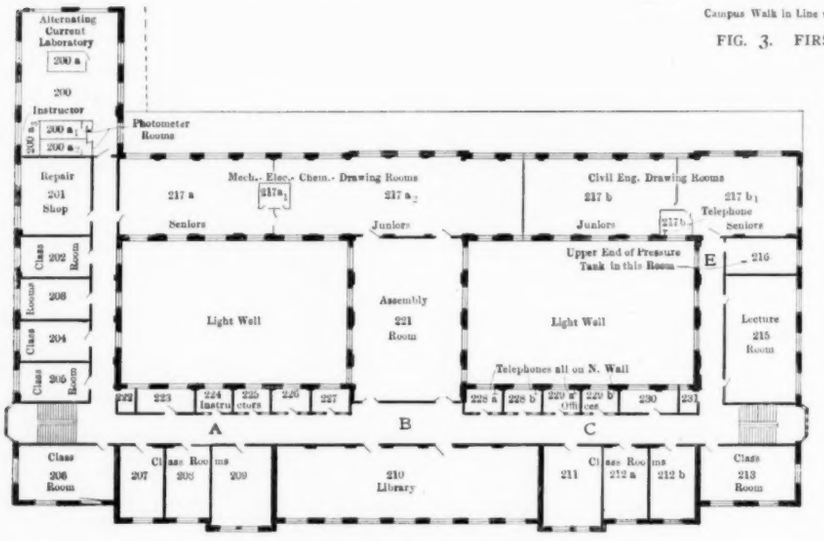


FIG. 4. SECOND FLOOR PLAN

by the physical testing and hydraulic laboratories of the civil-engineering department.

By looking at the plans of the upper floors, Figs. 4 and 5, it will be seen that the greater portion of the middle part of the building above the first floor is occupied by two large light wells. The bottom of these is formed by a glass roof over the shops below (and part of the laboratories) which in spite of their position in the interior of the building are, therefore, very well lighted. This portion of the building will now be described in detail.

THE SHOPS

The shops are used in the departments of mechanical, electrical and chemical engineering and consist of a foundry, a wood-working and pattern shop, a machine shop, and a smith shop. The students in the civil-engineering course do not take shop work.

The shops cover about 12,000 square feet of space on the ground floor, which includes, besides the shops mentioned, six offices for the instructors, and a large tool room in the center between the wood-working and iron-working shops.

THE FOUNDRY

Fig. 6 is a plan of the west end of the shops and shows the foundry and wood-working department. The foundry contains a 22-inch Colliau cupola and a brass furnace, with a one-ton jib crane alongside of the cupola and covering the floor; there are 10 molding troughs, tumbler, core-making machines, sand sifters, core oven, pickling vat and other foundry appurtenances.

WOOD-WORKING SHOP

Fig. 7 is a view in this department. The wood shop is equipped with 15 benches, ten 12-inch turning lathes and several wood-working machines. The pattern shop contains 15 work benches and 8 turning lathes of various sizes and makes, two band saws, a large tilting-table jig saw, a jointer, surface planer, combination circular rip and cross-cut saw, universal sanding machine, trimmers, tool grinder, glue heater, etc. The line shafting is driven by a 15 horse-power motor.

MACHINE SHOP

Fig. 8 is a plan of the east end of the shops, showing the iron-working, machine, and blacksmith shops, and Fig. 9 is a photographic view in this department. The beginners' iron-working shop contains a 15 horse-power Weston steam engine to drive the line shafting: the shop contains 8 benches, with 16 vises, seven 12-inch by 5-foot speed lathes, two 11-inch by 5-foot engine lathes, four 12-inch by 5-foot engine lathes, one 14-inch by 4-foot spinning lathe, two 20-inch drill presses, a power hack saw and emery wet-tool grinder.

What is known as the machine shop proper, in which the more advanced students work, contains two work benches with four vises, one 30-inch drill press, one 12-inch sensitive drill press, one Universal cutter grinder, Universal lathe and planer tool grinder, twist-drill grinder and emery wet tool grinder, three 12-inch by 5-foot speed lathes, four 12-inch by 5-foot engine lathes, two 14-inch by 6-foot quick-change-gear engine lathes, a 30-inch by 12-foot Lodge & Shipley high-speed engine lathe, driven by direct-connected 10 horse-power motor with apron control, a No. 1½ Garvin universal milling machine, a Brown & Sharpe universal milling machine, a No. 2 Cincinnati universal milling machine, direct driven by a variable-speed motor and having power feed in every direction, a 16-inch Kelley shaper, a 16-inch Walcott motor-driven shaper, a power

hack saw, a metal circular saw, an 18-inch by 18-inch by 5-foot Whitcomb planer, a 38-inch by 38-inch by 10-foot Gray spiral-geared planer with three heads and direct driven by a 10 horse-power motor, a Warner & Swasey screw machine, and an iron erecting floor served by a jib crane and piped for steam, water, gas and compressed air and wired for electricity. The line shafting of this portion of the shop is

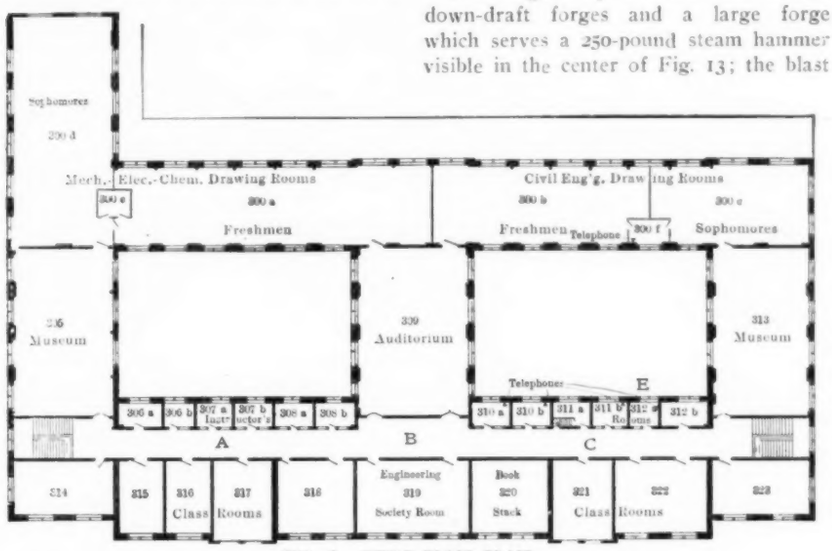


FIG. 5. THIRD FLOOR PLAN

driven by a 10 horse-power motor; it will be observed, however, that many of the machines have their individual motors; this fact and the variety in the makes of the machines installed tend to broaden the student's acquaintance with machinery. The small tools are all kept in the tool room already referred to, a regular check system being in use. Fig. 10 shows a standard tool case, and Fig. 11 standard chuck and face-plate case. There are 4 tool cabinets, each containing 80 drawers, and to each student is assigned a set of bench tools.

A slotter, Gisholt turret lathe, and Bliss press will soon be installed. Fig. 12 shows the standard machine-shop bench.

THE FORGE SHOP

The forge shop contains ten Buffalo down-draft forges and a large forge which serves a 250-pound steam hammer visible in the center of Fig. 13; the blast fan is direct driven by a 5 horse-power motor, and another motor of the same size drives the exhaust fan. There are nine 100-pound anvils, a drill press, emery grinder, power punching machine, pipe machine, and various other appliances. There is still another 5 horse-power motor to run the line shafting.

The shops collectively will accommodate about 90 men working at the same time.

THE METHOD OF INSTRUCTION IN THE SHOPS

One of the principles followed in this institution is to give each student as much individual attention as possible. Toward this end the classes are divided into small groups so that an instructor will not have more than say 10 men at once, and is therefore enabled to watch closely the work of each man, and give him such assistance as he may need. In the shop work each man gets his own particular job to do, and is required to use his own brains as much as possible in finding out how to do it, although, of course, the instructor is ready to point out defects in his methods. It is well to mention here that the *educational* idea is paramount, very little consideration being given to the idea of building machines for use or for sale. Because of the vast amount of information which there is to acquire in the business, and the comparatively very brief period in which the student has to work at acquiring it, it is very important that the highest educational efficiency should be aimed at all the time. If a student can attain a certain amount of manual dexterity, it is well and good; the central idea, however, is for him to acquire the habit of thinking, and to thoroughly understand the various processes, and he cannot therefore afford to spend time in repetition after he has once mastered any particular job. There is a certain time limit allowed to each operation, and if the student takes more than that time to perform it, he is conditioned. Of course he gets credit if he does better than the maximum time allowed. There is also a standard of workmanship, and if the work is not up to the

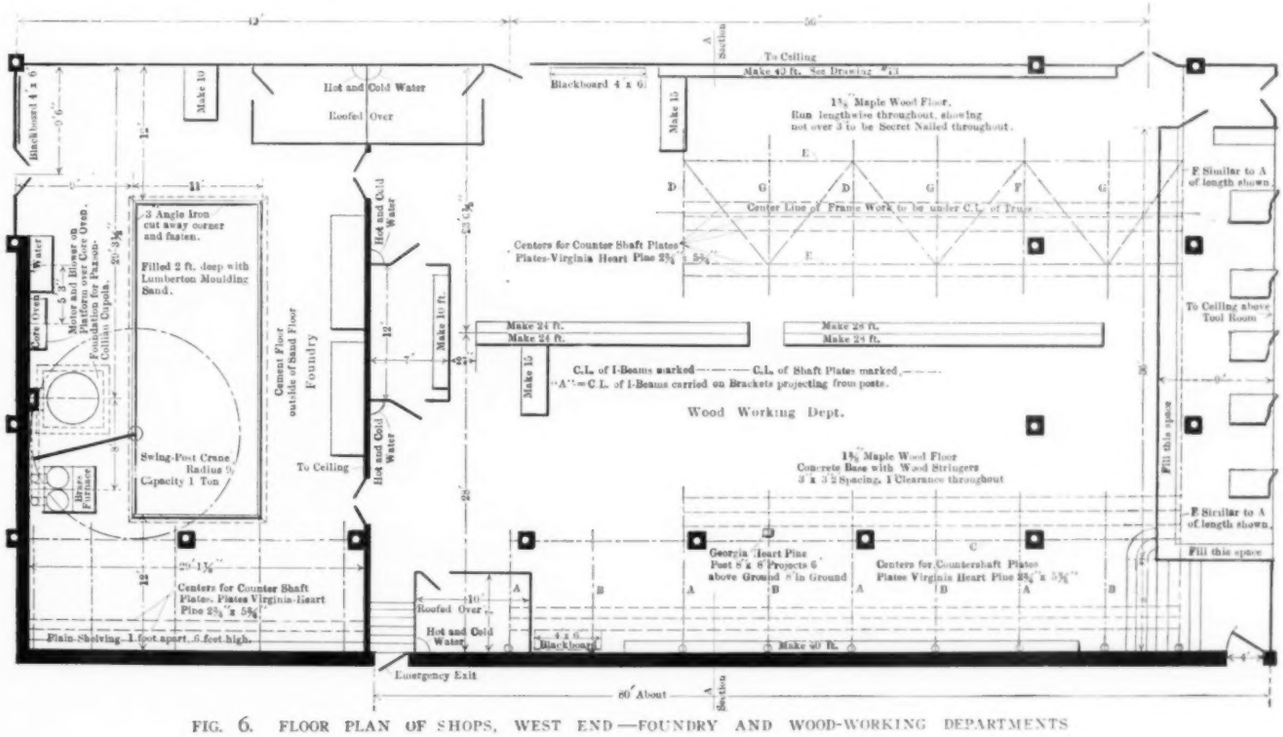

Hot and Cold Water
Roofed Over
Blackboard 4 x 6
Make 10
Make 15
To Ceiling
Make 42 ft. See Drawing
1¾" Maple Wood Floor.
Run lengthwise throughout, shoving not over 3 to be Secret Nailed throughout.
Center Line of Frame Work to be under C.L. of Truss
F Similar to A of length shown
Centers for Counter Shaft Plates
Plates-Virginia Heart Pine 2¾ x 5¾"
Make 24 ft.
Make 28 ft.
C.L. of I-Beams marked ——— C.L. of Shaft Plates marked - - -
"A" = C.L. of I-Beams carried on Brackets projecting from posts.
Wood Working Dept.
To Ceiling above Tool Room
3 Angle Iron cut away corner and fasten.
Filled 2 ft. deep with Lumberton Moulding Sand.
Motor and Blower on Platform over Core Oven. Foundation for Parson-Cottian Cupola.
Core Oven
Cement Floor outside of Sand Floor Foundry
Swing-Post Crane. Radius 9. Capacity 1 Ton
Brass Furnace
Make 10 ft.
1¾" Maple Wood Floor
Concrete Base with Wood Stringers
3 x 3 2 Spacing, 1 Clearance throughout
Fill this space
Georgia Heart Pine
Post 5 x 8 Projects 6 above Ground 8 in Ground
Centers for Countershaft Plates
Plates Virginia Heart Pine 2¾ x 5¾"
Centers for Counter Shaft Plates. Plates Virginia Heart Pine 2¾ x 5¾"
Plain Shelving 1 foot apart, 6 feet high.
Roofed Over
Hot and Cold Water
Blackboard
Make 20 ft.
Emergency Exit
80' About

FIG. 6. FLOOR PLAN OF SHOPS, WEST END—FOUNDRY AND WOOD-WORKING DEPARTMENTS

standard, it is rejected. The exercises are very largely machine parts; during the second term one of the machines in the laboratories or shop is turned over to the sophomores, and they take it apart and make sketches of its different elements, and by the end of the first term in the junior year they have made working drawings and traced them, and these go into the shop to be used to construct pieces from. If enough pieces are made to make a complete machine, it is assembled. The order of the student's work, however, is not interrupted for the sake of making a show-piece, nor is the practice followed of having certain parts of a machine, for instance, heavy castings, made outside and then completing the machine and regarding it as the product of the college shop. A pamphlet has been gotten up by J. J. Morris, superintendent of shops, setting forth all the jobs to be done, and to each one is a list of references to text-books, the AMERICAN MACHINIST and other journals, in which information on this kind of work can be found. Some time before the shop period in which a particular job is to be done, the student is notified of his assignment, so that he has a chance to read up his references and get a good theoretical knowledge of the work before he actually tackles it. He is required to make notes and turn them in for inspection. A very complete time-card system is in use, which enables the professor in charge to have on file a full record of the work of each student.

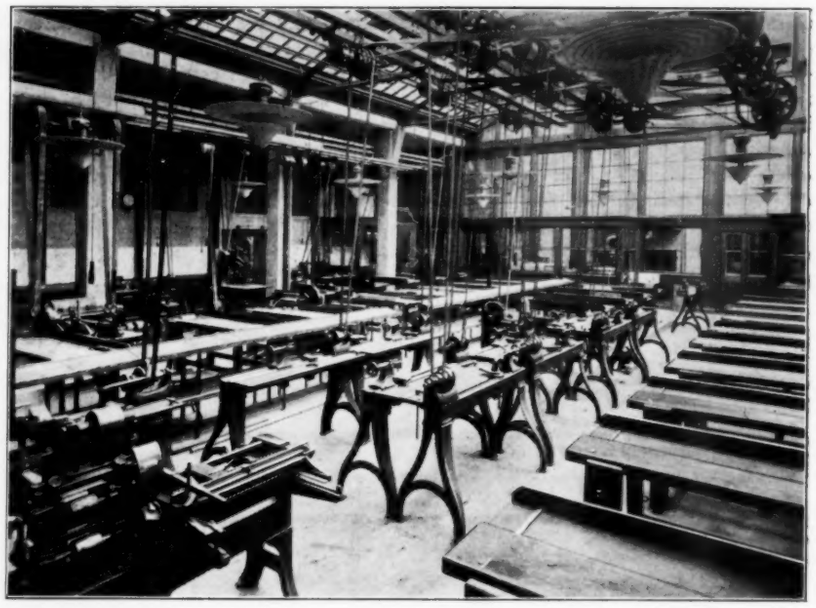


FIG. 7. WOOD-WORKING SHOP

THE LABORATORIES OF THE MECHANICAL ENGINEERING DEPARTMENT

The total floor space devoted to mechanical-laboratory purposes is 14,000 square feet. The mechanical laboratory is at the back of the building, north of the shop, and occupies also the northwest corner, taking up a space of 183 feet east and west, by 64 feet, with an L 40 feet by 38 feet, pointing to the north.

The steam, exhaust and water piping is run overhead, steam at 100 pounds pressure being supplied from the central light and heat station of the University. The electric current is carried throughout the laboratory so as to afford convenient power outlets for various motor drives. The laboratories, like the shops and other large rooms in the building, are lighted at night by inclosed arc lamps with diffuser shades, which give a brilliant illumination without being dazzling. Starting at the northwest corner of the building we find there a Roberts water-tube boiler of 100 horse-power, capable of carrying a pressure of 250 pounds per square inch. This boiler will supply either saturated or superheated steam for special experimental purposes, and alongside of it is a small erecting floor, upon which any kind of machine which it is desired to test may be mounted and connected up. South of the erecting floor are a few small apartments, one of which contains a ventilating and heating plant, consisting of blast fan and steam coil, and another of these rooms contains a complete refrigerating and ice-

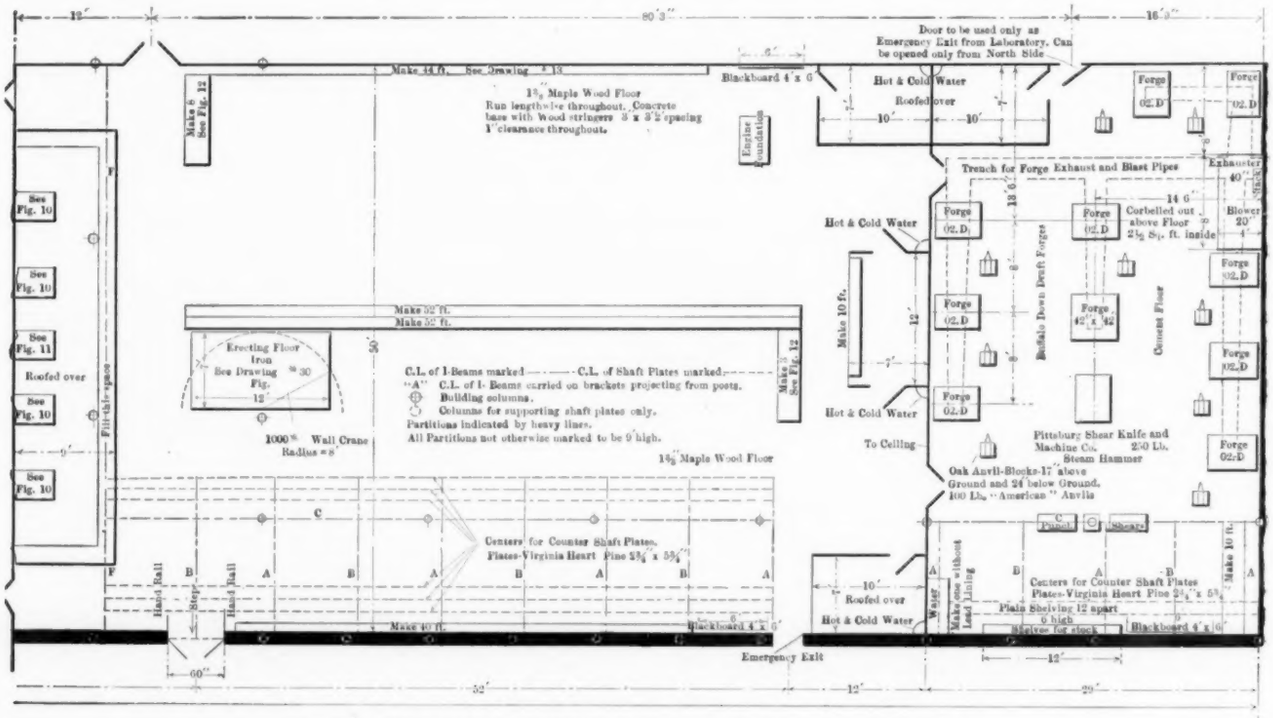

Door to be used only as Emergency Exit from Laboratory. Can be opened only from North Side
Make 44 ft. See Drawing
Blackboard 4' x 6'
Hot & Cold Water
Roofed over
Trench for Forge Exhaust and Blast Pipes
Exhaust 40"
Blower 20"
Corbelled out above Floor 2½ Sq. ft. inside
Buffalo Down Draft Forges
Cement Floor
Make 10 ft.
Make 32 ft.
Make 36 ft.
Erecting Floor Iron See Drawing Fig. 30
1000 lb. Wall Crane Radius = 8'
C.L. of I-Beams marked ——— C.L. of Shaft Plates marked ———
"A" C.L. of I-Beams carried on brackets projecting from posts.
Building columns.
Columns for supporting shaft plates only.
Partitions indicated by heavy lines.
All Partitions not otherwise marked to be 9' high.
1⅛" Maple Wood Floor
Pittsburg Shear Knife and Machine Co. 250 Lb. Steam Hammer
Oak Anvil-Blocks-17" above Ground and 24" below Ground. 100 Lb. "American" Anvils
To Ceiling
Centers for Counter Shaft Plates. Plates-Virginia Heart Pine 2¾" x 5¾"
Hand Rail
Step
Roofed over
Make 40 ft.
Emergency Exit
Plain Shelving 12" apart 6' high
Shelves for stock
Make one without Lead Lining
Water
Fire-hydrant space
See Fig. 10
See Fig. 11
60"
52'
12'
29'

FIG. 8. FLOOR PLAN OF SHOPS, EAST END—MACHINE AND FORGE SHOPS

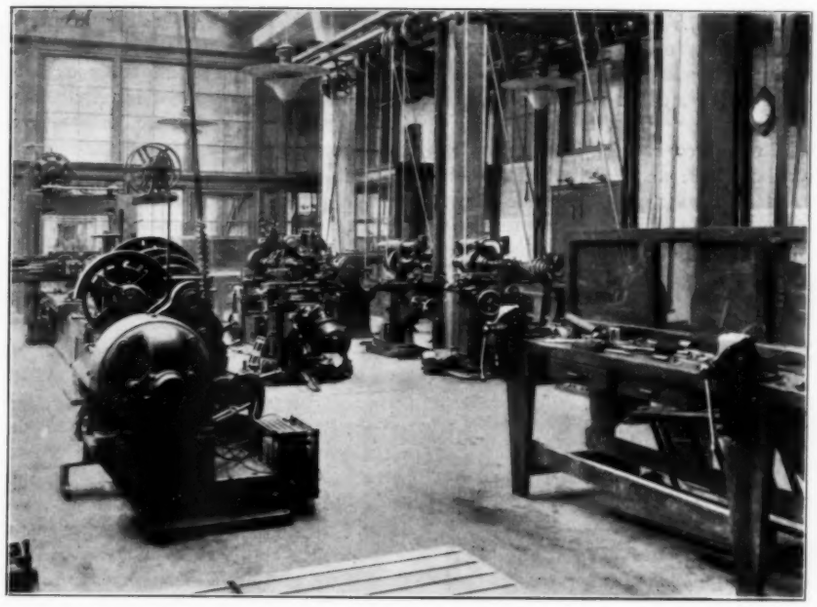


FIG. 9. IRON-WORKING SHOP

making plant, having a one-ton ammonia machine. Alongside of the wing of the building is a small lean-to, containing a cooling tower, and in which it is intended to also place a suction gas producer.

Inside of the laboratory in the neighborhood of the lean-to are a number of gas engines, to be run on city gas. This includes a 3 horse-power Warren engine, a 10 horse-power Springfield engine, a 30 horse-power two-cylinder vertical Westinghouse, and a 15 horse-power Burger. It is intended to install another one to be run directly from the suction gas producer.

Along the north wall of the building is what is called the steam laboratory, shown in Fig. 14, and consisting of a long line of steam engines, condensers, injectors, etc. The first one (not shown in the picture) is a small DeLaval steam turbine; beyond that is a Reeves vertical compound engine arranged for steam consumption tests, with a Wheeler surface condenser, and beyond that is a Buckeye engine similarly arranged (but which was not on its foundation when the picture was taken). An Ingersoll two-stage steam-driven air compressor of a capacity of 150 cubic feet of free air per minute is connected to a pair of receivers so that the air discharged can be measured continuously. Beyond this is a Harrisburg high-speed engine, next a steam pump and jet condenser and a Porter-Allen engine, an Ames engine, and a 10 and 24x60 inch Hamilton-Corliss, which, together with a Fairbanks slide-valve engine, is used for valve setting. Along the wall are several injectors, a pulsometer and an indicator tester. Near the eastern end of the room is a two-stage belt-driven air compressor, and an air blower.

The southeast corner of the room is occupied by the material-testing laboratory, Fig. 15, which contains two 30,000 pound Riehlé tension machines, one 30,000-pound and one 50,000-pound Olsen tension machine, a 60,000 inch-pound Riehlé torsion machine and a Thurston torsion machine. The tension machine and the Riehlé torsion machine are each motor driven with the speed control directly at the machine.

Along about the middle of the south

Specifications

Material:- Top, Ends, Faces of Case and Drawers, Red Oak, Planed, Dry, free from Knots and Shakes.
4-Angle Knees, ¼" x ⅜" x 3"-80-3" Bronze Pulls.
All other Wood, White Pine.
Finish:- One Coat of Filler and Two Coats of Varnish-Flatted.

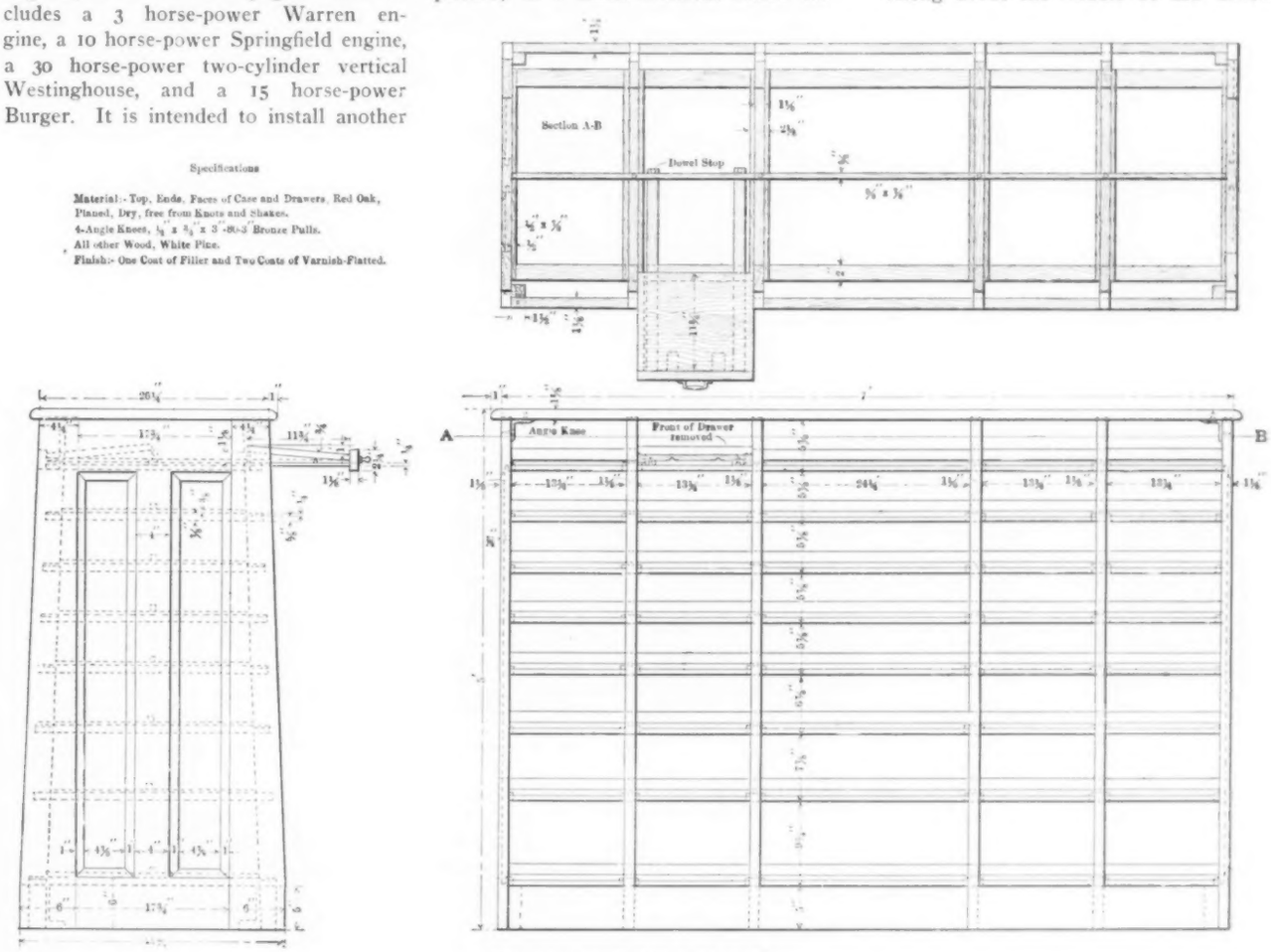


FIG. 10. STANDARD TOOL CASE

side of the large room is a dynamometer laboratory. This contains a Webber dynamometer, a Flather dynamometer and a Thurston railroad-oil tester, these machines being belt driven from a shaft driven by electric motor. A rope drive arranged for testing purposes is also being installed here.

There is an instrument room with all needed arrangements for taking care of and handling the small pieces of apparatus.

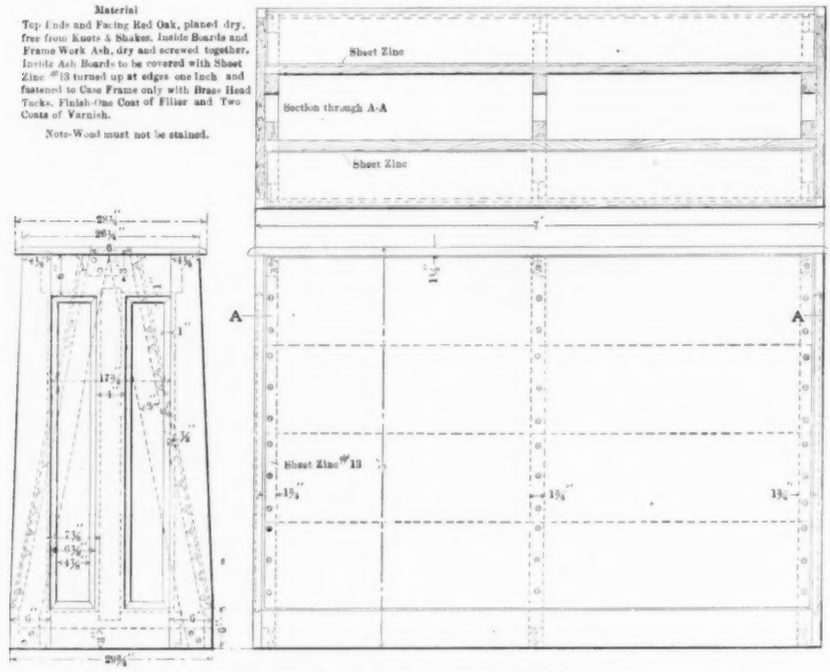

Material
Top Ends and Facing Red Oak, planed dry, free from Knots & Shakes. Inside Boards and Frame Work Ash, dry and screwed together. Inside Ash Boards to be covered with Sheet Zinc #13 turned up at edges one inch and fastened to Case Frame only with Brass Head Tacks. Finish-One Coat of Filler and Two Coats of Varnish.
Note-Wood must not be stained.
Sheet Zinc
Section through A-A
Sheet Zinc
Sheet Zinc #13
A
A

FIG. 11. STANDARD CHUCK AND FACE-PLATE CASE

The southwest corner of the room is occupied by the hydraulic department, which contains various pressure and receiving tanks, scales and pieces of apparatus for tests, including arrangements for testing gas meters, two Venturi meters, a 2-inch centrifugal pump, a Doble impulse wheel, a Pelton wheel and a Leffell reaction wheel; a hydraulic ram is supplied from a tank suspended from the ceiling. There is a seven-inch Morris centrifugal pump driven by a 30 horse-power motor, subject to float control, which takes the water from the cold-water cistern on one side of the hydraulic laboratory and pumps it into the 22,000-gallon storage tank in the attic. There are also two Ericsson hot-air pumping engines and a motor-driven triplex pump.

In connection with the mechanical laboratory it is proper to mention the instrument room, which is located to the left of the entrance on the first floor and is fitted up with tables, instrument cases, etc., and is to be used for coal calorimetry, gas analysis, gage calibration, indicator examination, planimeter examination and micro-photographic work.

The method followed in the laboratory work is somewhat similar to that already described for the shop work. A pamphlet is issued to the students, containing general instructions regarding the laboratory work and a list of all the experiments, with several reading references for each one, and to the student is issued, a week before he is to perform a given experiment, a report cover with instructions as to the conditions, etc., and during this advance time he reads up his references, and after making the experiment he turns in a full and complete report in the cover. The students work alone as much as possible, although, of course, on some experiments more than one observer is required. There is an instructor to about every eight students.

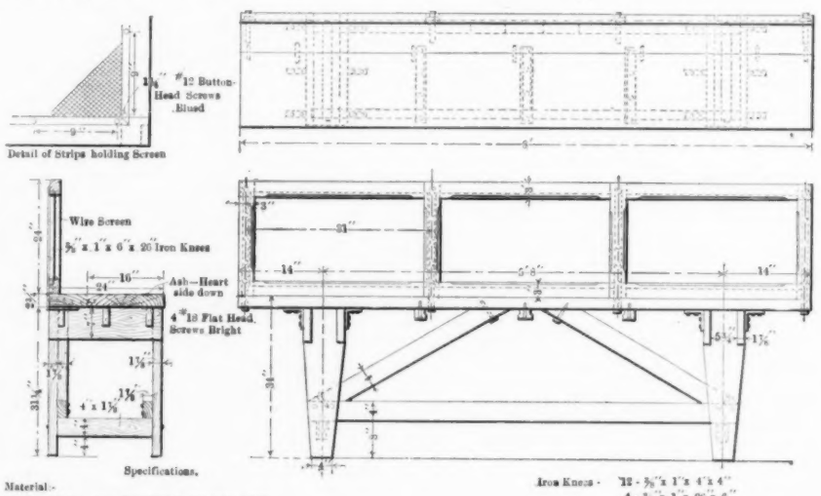

Detail of Strips holding Screen
Wire Screen
Ash—Heart side down
Specifications.
Material:-
Lumber - Ash - Dry - Free from Knots and Shakes.
Wire Netting, #16. Galvanized Iron. Mesh ¼.
Lag Screws - 4 - ⅜ x 8" with Washers.
4B - ¼ x 2" " "
4 - ⅜ x 3½" " "
12 - ⅜ x 3" " "
Iron Knees - 12 - ⅝ x 1 x 4 x 4"
4 - ⅝ x 1 x 20 x 6"
Flat Head Screws - Bright - 35 - 4" #13
36 - 1⅛" #12
Button - Head Screws - Blued - 4B - 1⅛" #12
Finish:-
Lumber planed all over
A Coat of Filler and One Coat of Varnish all over except Working Top of Bench.

FIG. 12. STANDARD MACHINE-SHOP BENCH

THE ELECTRICAL-INSTRUMENT LABORATORY

The instrument laboratory, Fig. 16, which is next east of the mechanical laboratory, is the one in which the electrical students first meet with their practical electrical work. In it are made experiments in the measurement of electromotive force, current, resistance, temperature coefficient, thermo-electric effect, inductance, capacity and permeability, the calibration of voltmeters, ammeters and wattmeters (indicating and integrating) and the determination of galvanometer constants. The floor space in this laboratory is over 4500 square feet, part of it being inclosed to form an apparatus room. Like the shops and mechanical laboratory it is largely under skylight. It contains also three instructors' offices and a small storage-battery room, so located as to divide the laboratory into eastern and western halves, assigned to the juniors and seniors, respectively, and each of these parts is again divided into sections, which permit of two separate lots of students of the same class working at once, if found convenient. On the junior, or eastern side there are accommodations for 24 men, and on the senior or western side, accommodations for 18 men. For each student there is a table and a galvanometer pedestal, which can be seen in Fig. 16, and which are shown in detail in Fig. 18. The former consists of two concrete columns, each about two feet high, carrying a slate slab 26x44 inches and 1½ inches thick; a little distance away from the table is a galvanometer pedestal which consists of one solid concrete column, with a slab 15x44 inches and 1½ inches thick, the pedestal being the same hight as the table. By providing these solid supports for the instruments, vibration is practically done away with. Each of the groups, both on junior and senior sides, is provided with its own switchboard (one is seen in Fig. 16) and its own storage-battery installa-

tion, the four switchboards being of white Italian marble like all the switchboards in the electrical laboratories. The wiring in this room is rubber covered and is run under the floor in easily accessible ducts; it is so arranged that any table can draw current from any source of supply.

The storage-battery equipment in connection with this laboratory contains, to each switchboard, 80 General Storage Battery Company cells, each of which has a capacity of three amperes for eight hours; they are so arranged that any combination can be obtained by means of dial switches on the switchboard. There are, moreover, to the senior boards, 18 Westinghouse cells capable of supplying 15 amperes each for eight hours, intended for purposes where a large current and low electromotive force is required, the other cells being used where high potential and low current strength are needed. The junior boards each have six of these cells. As there are four switchboards there is a total of 320 of the small cells and 48 of the large cells, 36 of the latter being for the two senior switchboards and 12 for the two junior switchboards. Each senior switchboard has connected with it a two-kilowatt alternator.

The apparatus room contains about 45 galvanometers, about 60 different standard resistance boxes, ranging in resistance from 1/10 ohm to 1 megohm, 18 standard condensers, alternating- and direct-current integrating wattmeters, galvanometer shunts, etc.

This laboratory contains a complete quadruplex telegraph equipment on the Western Union system, to enable students to become acquainted with the construction and care of the apparatus. Its case with sloping glass top is visible in Fig. 16.

The room at the southwest corner of the building, on the main floor, will form what might be called the "local bureau of standards," in which all standardizing work for electromotive force, resistance, capacity, inductance and electrical quantities and instruments in general can be done.

THE DIRECT-CURRENT DYNAMO LABORATORY

This room is at the west end of the building, on the first floor, and has a floor space of over 2000 square feet, being 33 feet by 62 feet, and it includes an instrument room and instructor's office. The wiring is installed in a manner similar to that in the laboratory already described, the wires being fire and weather proof, not rubber covered. Fig. 17 is a photographic view in this room, and Fig. 19 is a floor plan, which also shows the raised concrete foundations provided for mounting the dynamos and motors used in the tests. There are twelve of these testing beds of different sizes. It will be seen that the concrete bases are surmounted by wooden runners of yellow pine, upon which at right angles are placed iron straps. The straps are screwed to the wood, and the wood is bolted to the concrete. The machine rests upon the iron straps, and by a simple device may be clamped in any desired location, the straps of flat iron acting as abutments to resist the pull of the belt. The wood serves to absorb the vibration produced by the machines. At each testing bed there is provided a table and terminal board, the table being attached to the concrete to avoid vibration from the machine. As previously stated, the main power supply is direct current at a potential of 110 volts, being supplied by the generators in the building.

(To be concluded.)

FIG. 13. FORGE SHOP

FIG. 14. THE STEAM LABORATORY

A long series of experiments has been completed at Purdue University affecting certain processes to increase the life, strength and physical qualities of timber. These processes are regarded necessary because of the steady diminution of the timber supply. The feeling is prevalent that everything possible should be done to increase the durability of the timber that is now being used for various purposes. The experiments at Purdue have been made chiefly in the interests of railroads by making mechanical tests of the ties treated by different processes. Over 400 ties were used, and upward of 600 tests were made. The timber-testing laboratory at Purdue is the one used by the government at the St. Louis Exposition. —*Western Electrician.*

THE TECHNICAL SCHOOL AND THE UNIVERSITY

Practical Scientific Training—Its Importance in the Life of the Community

BY PROF. W. H. BURR

In connection with the recently held opening exercises of Columbia University, Prof. W. H. Burr, head of the Department of Civil Engineering, delivered an address in which, after briefly going over the history of the development of universities and the changes of sentiment that have taken place with regard to the character of the studies that should be pursued in them, he gave his ideas as to the relation that should exist between the technical schools and other departments of institutions of learning, from which we quote as follows:

AN ARISTOCRACY OF LEARNING

In the early history of universities it constituted a sort of purveyor of privileged or aristocratic learning ostensibly of better birth than the professional faculties of law and medicine, which had the misfortune to deal with the actualities of life on which the welfare and safety of communities no less than the rights and duties of individuals are fundamentally based. This conventional class distinction constituting a kind of snobbery of learning was the real influence or force so completely overcome by the movements of Humanism and the Reformation, and it has bequeathed to us the useless and senseless term "pure" science as opposed to applied science; as if there could be in some way a science politely distilled as an essence of learning separated from the realities with which absolutely all science whatever has to deal and without which no science whatever can exist. . . .

During the latter part of the eighteenth and throughout the nineteenth centuries the extensions of all branches of physical science so enlarged their fields of application that the foundations were laid of another distinct and prominent faculty. The great investigators in chemistry, in physics, in biology and in the marvelous combinations and ramifications of those and other affiliated sciences were the pioneers in the service rendered by science to the creation of the industries of the world which have been such potent agents in the extraordinary advancement of civilization during the past 150 years. Every addition to scientific knowledge, meaning simply a closer contact with the realities of our natural environment, has supplied a corresponding field of activity for useful effort and in just that much has enlarged the meaning and the volume of life. . . .

The practice of every technical profession is founded upon precisely that quality and kind of knowledge established by investigation and by instruction at those centers of learning, which only have been the originators and transmitters of useful knowledge from the earliest beginnings of science to the present day. Although there has been much scientific investigation and remarkable applications of science to human activities by individuals or in communities, to whom apparently even the meaning of university work was unknown, the fundamental principles on which the value of the subsequent technical work is wholly based will be found in practically or absolutely all cases to have germinated in the fertile soil of the university.

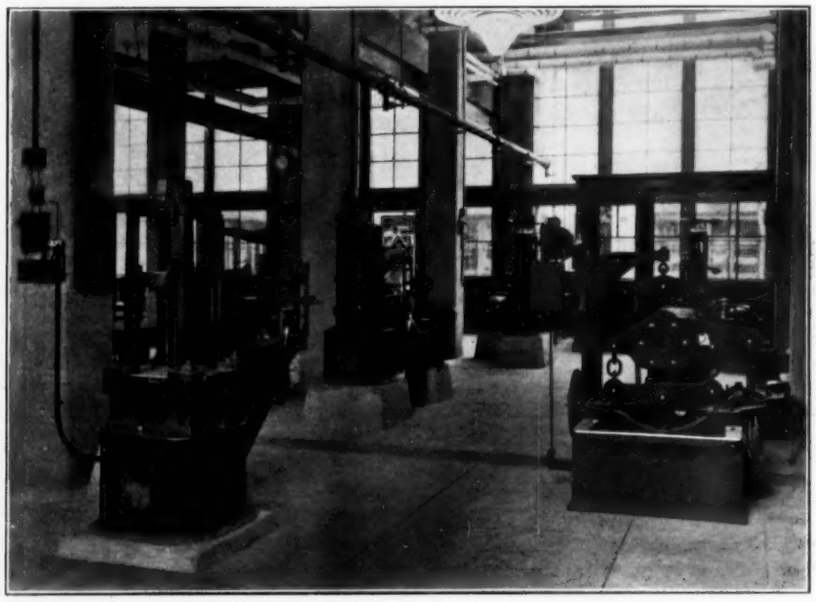


FIG. 15. MATERIAL-TESTING LABORATORY

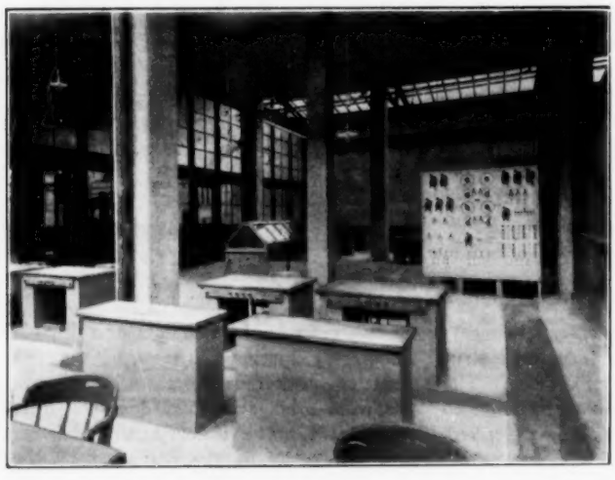


FIG. 16. ELECTRICAL-INSTRUMENT LABORATORY

FIG. 17. DIRECT-CURRENT DYNAMO LABORATORY

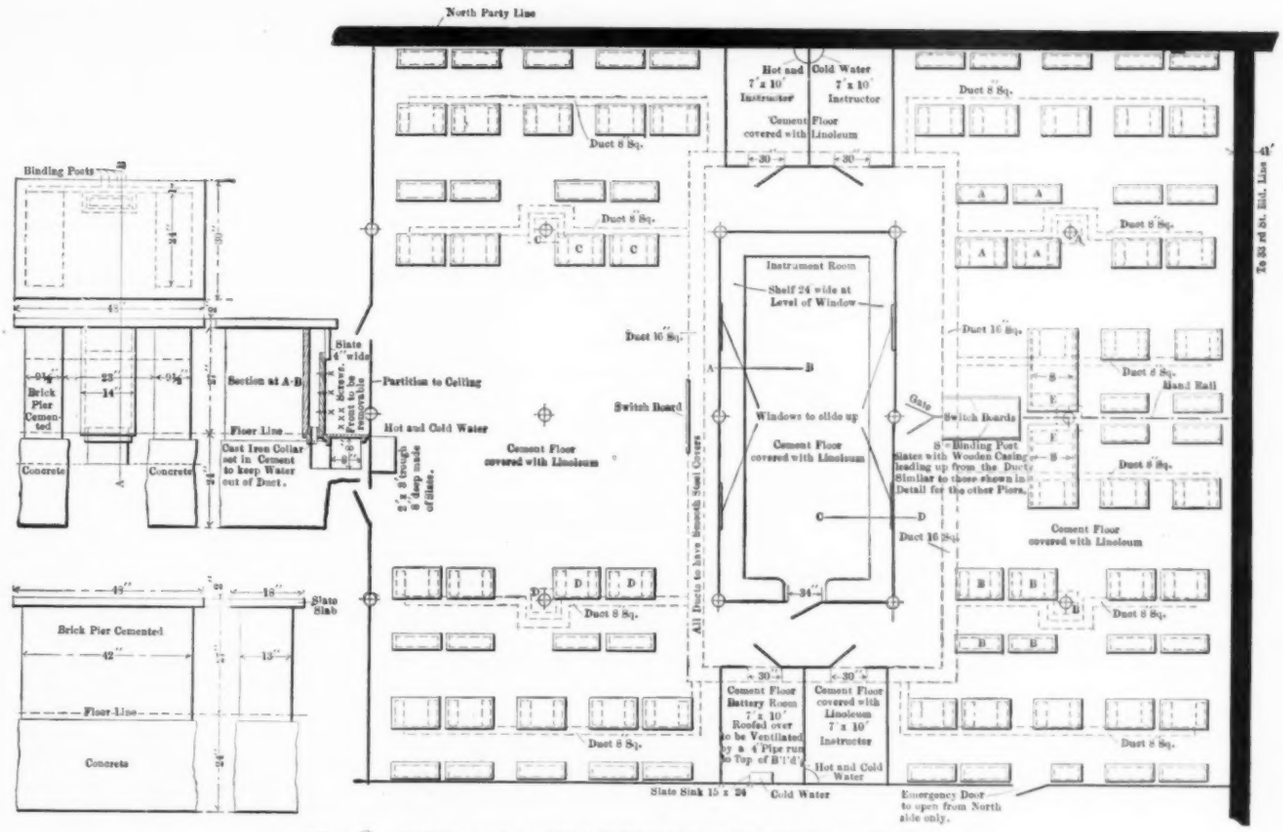

North Party Line
Hot and Cold Water Instructor
Cement Floor covered with Linoleum
Duct 8 Sq.
Binding Posts
Brick Pier Cemented
Concrete
Section at A-B
Partition to Ceiling
Floor Line
Cast Iron Collar set in Cement to keep Water out of Duct.
Hot and Cold Water
Cement Floor covered with Linoleum
Slate 6" wide
Switch Board
Instrument Room
Shelf 24 wide at Level of Window
Windows to slide up
Duct 16 Sq.
All Ducts to have Smooth Steel Covers
Gate
Switch Boards
Hand Rail
Slate Slab
Brick Pier Cemented
Floor Line
Concrete
Cement Floor Battery Room 7' x 10' Roofed over to be Ventilated by a 4" Pipe run to Top of B'l'd'g.
Cement Floor covered with Linoleum 7' x 10' Instructor
Hot and Cold Water
Slate Sink 15 x 24
Cold Water
Emergency Door to open from North side only.
To 33 rd St. Elev. 42'

FIG. 18. SENIOR AND JUNIOR ELECTRICAL-INSTRUMENT LABORATORY

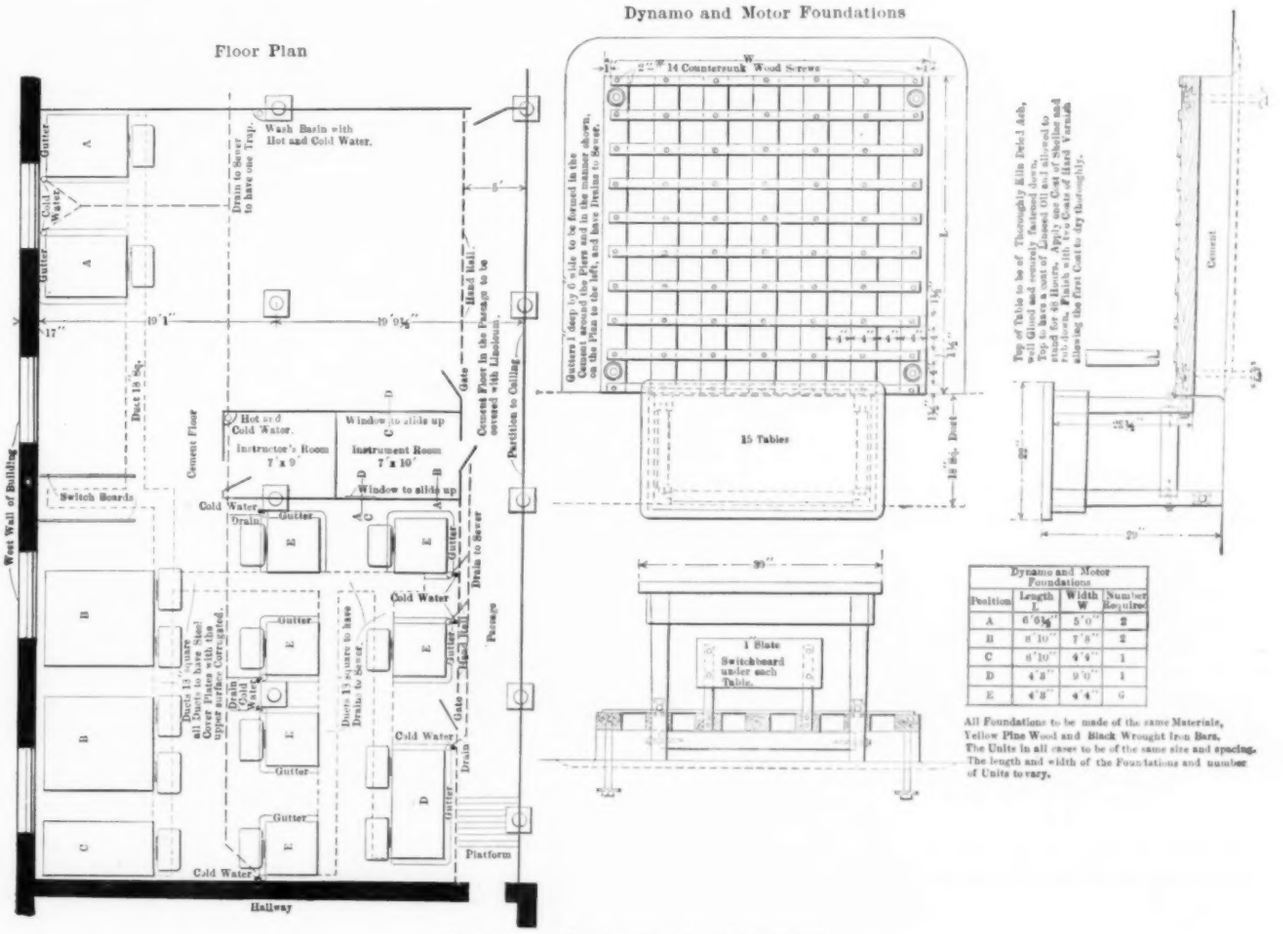

Floor Plan
Dynamo and Motor Foundations
Wash Basin with Hot and Cold Water.
Drain to Sewer to have one Trap.
Gutter
Cold Water
Duct 16 Sq.
Cement Floor
Hot and Cold Water.
Instructor's Room 7' x 9'
Window to slide up
Instrument Room 7' x 10'
Switch Boards
West Wall of Building
Cold Water
Drain
Drain to Sewer
Hand Rail
Cement Floor covered with Linoleum.
Partition to Ceiling
Gate
Passage
Platform
Hallway
14 Countersunk Wood Screws
15 Tables
1 Slate Switchboard under each Table.
Cement
Dynamo and Motor Foundations
Position | Length L | Width W | Number Required
A | 6'0½" | 5'0" | 2
B | 8'10" | 7'8" | 2
C | 6'10" | 4'4" | 1
D | 4'8" | 9'0" | 1
E | 4'8" | 4'4" | 6
All Foundations to be made of the same Materials, Yellow Pine Wood and Black Wrought Iron Bars. The Units in all cases to be of the same size and spacing. The length and width of the Foundations and number of Units to vary.

FIG. 19. ELECTRO-DYNAMIC LABORATORY

THE BEGINNINGS OF TECHNICAL EDUCATION

The initial stages of technical education took form first in the universities of Europe. The subsequent development of that educational work into complete technical faculties is found to have been practically concurrent in the universities of Europe and America, although the former have precedence in time over the latter by comparatively short periods. These faculties have not always been known by the names of the professional practice for which it is the purpose to prepare their students, but the apparent defect in the continuity of the case is not real. In the earliest university courses of technical study instruction was given in a substantial number of technical subjects under a faculty of broader jurisdiction than that confined to a technical profession, and in some of them that method is pursued even at the present time. Such courses of study effectively answered their purpose in the early days of the engineering and allied professions, but their administration has generally been advanced by a natural development concurrent with the growth of the professions which they have served, to remarkable groups of technical faculties of such prominence and intellectual strength, and with such numbers of students as almost to dominate the true university in some cases, and even to form essentially technical universities in others.

THE INTER-RELATION OF ALL KNOWLEDGE

These great technical faculties have been the direct results of the dissemination of knowledge by the university. Even the professor who has boasted that he never wittingly either learned or taught anything useful, has been the servant of real learning by extending the limits of scientific knowledge which refuses to be hindered or circumscribed by its narrowest and most erratic votaries. Wherever there has been a seat of learning, from that point has issued a quickening influence, which has stimulated the growth of every form of useful activity. All the great industries on which the prosperity of every civilized nation is based, have originally sprung from small beginnings which had their initial impulse from some branch of knowledge, acquired in the first instance at the university.

So closely are all forms of knowledge related in their fundamental elements that no one of them can attain to a state of real growth without carrying others more or less with it. This elementary principle which finds illustrations and the most conclusive proof in every field of educational experience underlies the fundamental organization of the university, and it completely justifies the place of the technical school in the university plan. Further than that, it illuminates in a clear and instructive manner the natural development of an institution of universal learning. . . .

The more complete the view of the field covered, the more satisfactory will be the student's work in it. In fact it may be stated that the real study of any one part of the field of knowledge consists in acquiring information relating to its effect upon other fields into which it reaches. It is impossible to conceive of any subject of scientific study as an abstraction either from other subjects or from the material elements of experience. . . .

The university has long since lost the character, if it ever properly had it, of a place where abstractions of learning separated from the things which only give them life are to be dispensed after the manner of instruction to men who are never to deal with the affairs of life. It has come to be an intensely practical working agent. It is effective and worthy of support only in so far as it makes itself felt in the real life of the community. If it is to be a true and real center of instruction it is imperative that it shall carry knowledge into every useful calling, governmental, corporate or private.

INFLUENCES UPON PUBLIC LIFE AND MORAL PERCEPTIONS

The opportunities offered in the administration of both public affairs and the great corporate interests of the present time, rapidly increasing in number and magnitude, create almost irresistible temptations to prostitute them to selfish gain. The realization that great power, or what has now come to be its full equivalent, great wealth, is a grave and delicate trust, to which selfish gratification in its infinite and seductive variety is abhorrent, comes most naturally and easily through sound knowledge—"the beginning of wisdom."

The true student of the technical or professional school becomes heir to a comprehensive and clear understanding of his duties and responsibilities in his relations to his fellow men and to the community. Those duties and responsibilities present themselves to his trained mind in their real proportions. He is neither non-developed nor mal-developed in his judgment of affairs. His university training, especially in the technical school, has taught him accuracy and penetration in the analysis of any proposition confronting him, and that truth and knowledge must be sought with the directness of a plumb line. Science yields nothing but confusion to the shifty, devious and dishonest inquirer. The fundamentals of morality are the very stepping stones to technical success or professional attainment.

The correct conception of his duties gives to the professional man such a deep and true sense of his responsibilities as to render him the safest administrator of those great interests whose sinister power has already threatened both the morals and the safety of the community. Selfish gratification is a temptation to which he may or may not yield, but his inheritance from the university translates wealth to be a means of accomplishing the highest purposes of life, and saves him from that narrow, common complaisancy of wealth which is the dry rot of character. . . .

EXPERIENCED AND "PRACTICAL" INSTRUCTORS IMPERATIVELY DEMANDED

A living and forceful quality can be given to instruction in no other way whatever but by actual contact with the things encountered in practical experience and precisely in the relations disclosed by that experience.

Some of the professional faculties have already benefited by this quickening and energizing influence of living contact with their professions. The medical faculties are composed largely of eminent practitioners and it is not too much to say that it would be impossible to give the requisite instruction were it otherwise. It is well known that the most serious defects in the present educational administration of the university faculties of law and engineering are due to the fact that too many instructors fail of that true development and broad training gained only by actual professional experience. It may be confidently stated that instruction in professional engineering subjects cannot now be given with the necessary breadth and efficiency without supplementing the imperatively necessary work of the study by extended practical experience. And those observations are not peculiar to the faculties to which they are applied. The time has already come when the professional faculties, and preëminently so those of the technical schools, must be active, living parts of their professions. There is no other way by which they can either properly discharge their own functions or become members of a university organization strengthened and equipped to meet its wide educational responsibilities which make it one of the greatest conserving and elevating forces of the community.

The technical schools constituting the great modern professional schools of the university are integral parts of it and necessary consequences of its natural evolution. They belong to it historically and naturally. They are professional schools and professional schools not only belong to the university, they are the university.

The electric train service on the recently electrified line of the Pennsylvania Railroad between Philadelphia (Camden) and Atlantic City commenced on September 18. Hourly trains make the run in 90 minutes.

A 1600 horse-power engine, the largest marine gasolene engine yet constructed, is being shipped from Baltimore to Russia. It is one of four ordered by the Russian government, the price being $100,000.

Several blast-furnace columns of cast iron, each 27 feet long, 27 inches bottom diameter and 24 inches top diameter and weighing 16,180 pounds, were recenty cast in the Hansell-Elcock foundry, Chicago.

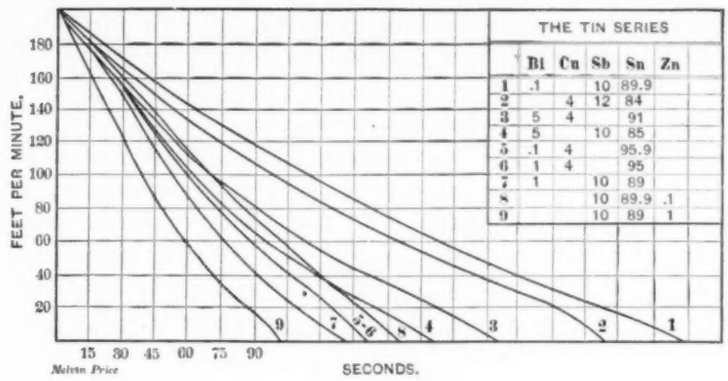


FIG. 6

THE TIN SERIES.

Bi (.1). Sb (10). Sn (89.9). No. 1.

Performance.	Time in dropping from a speed, in r. p. s. of										
	55 to 50	50 to 45	45 to 40	40 to 35	35 to 30	30 to 25	25 to 20	20 to 15	15 to 10	10 to 5	15 to 0
A.	17	20	24	22.5	21.5	28	29	35	20	21	20
B.	20	17	17	20	24	25	33	31	37	43	35
C.	....	17	20	22	26	27	32	34	46	53	39
D.	....	17	20	20	25	25	25	33	25	29	46
E.	....	21	22	22	26	30	29	33	33	58	43
X.	20.1	18.6	20.9	21.6	24.6	27.3	29.8	33.7	31.7	39.8	36.4
Number of period.	11	10	9	8	7	6	5	4	3	2	1

Cu (4). Sb (12). Sn (84). No. 2.

Performance.	Time in dropping from a speed, in r. p. s. of										
	55 to 50	50 to 45	45 to 40	40 to 35	35 to 30	30 to 25	25 to 20	20 to 15	15 to 10	10 to 5	5 to 0
A.	....	....	14	15.5	18	17	19	21.5	23	25.5	21
B.	14	15	20	19	23	25	28	32	31	37	22
C.	....	....	22	26	28	33	37	39	39	41	25
D.	....	....	19	22	26	28	32	32	32	30	20
E.	....	11	17	17	21	21	25	30	37	38	15
X.	....	13.8	18.5	19.9	23.3	24.7	28.1	30.9	32.2	34.6	21
Number of period.	11	10	9	8	7	6	5	4	3	2	1

Bi (5). Cu (4). Sn (91). No. 3.

Performance.	Time in dropping from a speed, in r. p. s. of										
	55 to 50	50 to 45	45 to 40	40 to 35	35 to 30	30 to 25	25 to 20	20 to 15	15 to 10	10 to 5	5 to 0
A.	....	....	15	15	16	17	17	19	21	21	25
B.	....	10	10	12	13	16	16	20	23	26	27
C.	....	....	....	10	7	8	18	13	24	28	29
D.	....	....	17	18	20	24.5	25.5	29	31	36	23
E.	....	....	....	20	20	24	25.5	29.5	36	37	25
X.	....	10.9	14.3	14.6	14.8	17.4	20.3	21.6	26.9	29.5	26.7
Number of period.	11	10	9	8	7	6	5	4	3	2	1

The Microstructure and Frictional Characteristics in Bearing Metals II*

BY MELVIN PRICE

In the *tin series* we have a greater variety of third constituents. At the high speed the curves differ little except in direction, being nearly straight lines. Nos. 2, 8 and 9 have noticeably reverse curvature at lower middle speeds, with the abrupt down-turning at very low speeds. Of these 2, which is Babbitt's metal, has the gradual variation of the aluminum series. Nos. 8 and 9 are entirely similar, differing only in the value of the resistance, indicated by their slopes, and it is seen that their compositions differ only in the proportions of the third constituent, zinc.

For the first time we now come across curves which exhibit no sign of abrupt change of resistance in passing from lower middle to low speeds. Nos. 1, 3, 4, 5, and 6 have nearly the same slopes throughout these low speeds. In 7 there is even a slight opposite or upturning tendency in contrast with the curves we have heretofore examined. In the table it may be noticed that these alloys all contain bismuth, but in varying proportions and alloyed with copper and tin in three instances and with antimony in the others.

Consideration of the tin series tends to confirm the belief in the general principle that composition determines frictional characteristics, since the peculiar shape of curves 8 and 9 have occurred only when zinc was a constituent and that 1, 3, 4, 5, 6 and 7 only when bismuth was present. Admitting that in all probability there is no method of measuring absolutely the frictional resistance, it may be interesting to note, nevertheless, that the only difference in similar curves is one of slope, and that the only difference in the composition is the proportion of the third constituent. Here the third constituent may be regarded as either of the two low percentage constituents, so that without some discussion of the microstructures we may not even guess which of the two influences the slope. In this connection we may notice, however, that curves 5 and 6 coincide throughout; and that their compositions differed only in the proportion of bismuth, the percentage of copper being equal: while 3 and 4 have the same percentage of bismuth, different slopes throughout, and different third constituents, viz., Cu and Sb. Similarly for curve 6 and 7. These characteristics contribute toward the impression that, of the two low percentage constituents, one contributes to the shape of the curve or determines its law of variation with speed, while the other determines the absolute value of the resistance at any given speed. To use a mathematical expression, *one*

*Presented at the Scranton meeting of the American Society of Civil Engineers.

constituent determines the law of the variation, and the other the constants of that law.

Looking at the sheet of curves taken from miscellaneous alloys, we have in 1 a long, sweeping curve, nearly straight at high speeds; more variation, but gradual, at medium speeds, and considerable reverse curvature at lower speeds, with a down-turning at the lowest points. This alloy is rich in Pb. Reverting to the curve of pure Pb we see striking similarities. Now antimony and tin are the other constituents of 1. And it is thought that these form the chemical compound of SbSn. In the absence of other data we might say that probably the difference in resistance noted is a consequence of the presence in the alloy of grains of this chemical compound, which is vastly different in some physical properties from the Pb of the matrix.

In the other three curves on the sheet marked "Miscellaneous Alloys" we have a portrait of the frictional behavior of the yellow alloys of aluminum and copper. Here we may regard the manganese as the third constituent. The curves, 2, 3 and 4, nearly coincide. The greater portions or 2 and 4 are straight, while 3 has a slight tendency toward downward convexity. All have the reversal at lower middle speeds and a slight tendency to abrupt down-turning at low speeds. Curve 4 is that of an alloy having 20 per cent of manganese, while in 2 and 3 the percentage of manganese was respectively 0.1 and 1. This makes it appear that in these instances the percentage of the third constituent has had little or no effect.

Microstructures.—In the writer's laboratory at the University of Nebraska, about one year after the above resistance data were taken, the alloys were examined with the microscope. The original ingots, which had been shaped into bearings for the resistance tests, were sectioned, polished with rouge and water upon a wheel faced with baize, etched by a light acid attack, and magnified for examination.

If we are to look for confirmations in the microstructures of any beliefs suggested by frictional performances, we must, of course, neglect the effect of the year's time which has elapsed between the tests and the examinations which will now be recorded. It has been established that changes in granulation occur after solidification. It was notably established also by Roberts-Austen, in his gold-lead experiment, that solid solutions may be formed without resorting to liquifaction by heat. However, the writer made examinations of the above alloys concomitantly with the frictional tests at the Columbia University laboratory, and so far as he is able to remember, nothing found then had vanished when the work was taken up a year later, although many peculiarities were revealed in the latter examinations which did not reveal them-

Bi (5). Sb (10). Sn (85). No. 4.

Performance.	Time in dropping from a speed, in r p s. of										
	55 to 50	50 to 45	45 to 40	40 to 35	35 to 30	30 to 25	25 to 20	20 to 15	15 to 10	10 to 5	5 to 0
A.	....	....	....	17	15	17	16	17	30	32	20
B.	9	7	11	11	9	10	13	14	17	20	24
C.	....	13	9	7	7	8	5	14	23	23	26 5
D.	10	13	18	19	17	19	21	24	25	30	26
E.	....	8.5	9.5	12	12	13	17	19.5	23 5	31	28
X.	9.6	11	12.2	12.9	11.7	13.1	13.9	17.7	24.1	27 3	25.9
Number of period	11	10	9	8	7	6	5	4	3	2	1

Bi (.1). Cu (4). Sb (95.9). No. 5.

Performance.	Time in dropping from a speed, in r. p. s. of										
	55 to 50	50 to 45	45 to 40	40 to 35	35 to 30	30 to 25	25 to 20	20 to 15	15 to 10	10 to 5	5 to 0
A.	....	10	8	9	10	10	10	14	19	27	20
B.	....	....	13	12	12.5	13.5	13	15	17	17	16
C.	....	10	11	12	13	13	15	16	20	21	15
D.	....	....	11	14	13	15	16	19	20	23	18
E.	....	10	12.5	10.5	8.5	7.5	7.5	16	20.5	22.5	19
X.	....	10.5	11.3	11.6	11.3	11.6	12.2	16.2	19.6	22.5	17.9
Number of period	11	10	9	8	7	6	5	4	3	2	1

Bi (1). Cu (4). Sn (95). No. 6.

Performance.	Time in dropping from a speed, in r. p. s. of										
	55 to 50	50 to 45	45 to 40	40 to 35	35 to 30	30 to 25	25 to 20	20 to 15	15 to 10	10 to 5	5 to 0
A.	....	....	13	12	12.5	13.5	13	15	17	17	16
B.	....	....	11	14	13	15	16	19	20	23	18
C	....	10	12.5	10.5	8.5	7	7.5	16	20.5	22.5	19
D.	....	13	12	12	10	13	17	18	19	22	20.5
X.	....	11.7	11.9	12.1	11	12	13.2	17	19.2	21.2	18.4
Number of period	11	10	9	8	7	6	5	4	3	2	1

Bi (1). Sb (10). Sn (89). No. 7.

Performance.	Time in dropping from a speed, in r. p. s. of										
	55 to 50	50 to 45	45 to 40	40 to 35	35 to 30	30 to 25	25 to 20	20 to 15	15 to 10	10 to 5	5 to 0
A.	....	....	....	7	8	9	9	8	11	13	17
B.	....	....	12	9	8	8	8	7.5	7.5	14	17
C.	....	....	....	15	14	12	13	16	10	13	19
D.	....	11	8	9	10	10	12	20	14	15	27
E.	....	....	....	....	....	16	16	17	20	21	25
X.	....	9.5	11.7	11.1	11.0	11.0	11.5	13.3	14.4	15.5	21.2
Number of period	11	10	9	8	7	6	5	4	3	2	1

Sb (10). Sn (89.9). Zn (.1). No. 8.

Performance.	Time in dropping from a speed, in r. p. s. of										
	55 to 50	50 to 45	45 to 40	40 to 35	35 to 30	30 to 25	25 to 20	20 to 15	15 to 10	10 to 5	5 to 0
A.	....	....	....	8	8	10	8	10	12	17	13
B.	....	....	....	8	8	10	8	10	12	17	13
C.	....	....	5	7	6	7	12	15	18	21	16
D.	7	6	6	8	6	8	8	9	9	16	12
E.	7	7	12	6	8	7	9	10	15	19	15
X.	....	7	7.7	7.5	7.3	8.5	8.9	10.7	13.0	18.1	13.8
Number of period	11	10	9	8	7	6	5	4	3	2	1

Sb (10). Sn (89). Zn (1). No. 9.

Performance.	Time in dropping from a speed, in r. p. s. of										
	55 to 50	50 to 45	45 to 40	40 to 35	35 to 30	30 to 25	25 to 20	20 to 15	15 to 10	10 to 5	5 to 0
A.	....	....	....	14	13	12	13	13	15	17	15
B.	....	....	14	14	12	14	14	14	16	18	16
C.	....	....	15	15	15	15	16	16	18	19	16
D.	....	15	14	15	16.5	15.5	15	17	19	21	17
E.	....	....	18.5	15.5	16	15	16	17	20	20	18
X.	....	14	14.9	14.5	14 5	14.3	14.8	15.3	17 6	19.0	17
Number of period.	11	10	9	8	7	6	5	4	3	2	1

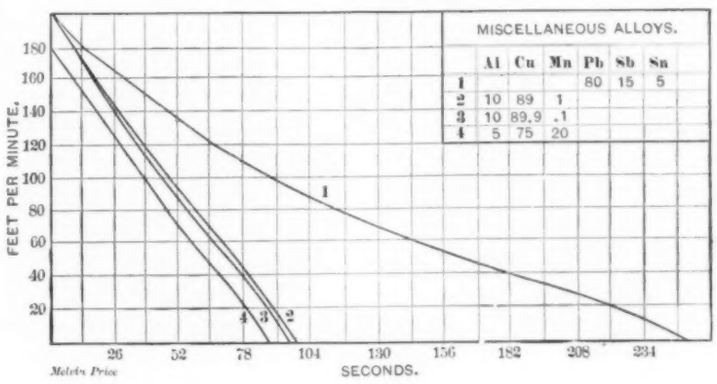


FIG. 7

MISCELLANEOUS ALLOYS.

Pb (80). Sb (15). Sn (5). No. 1.

Performance.	Time in dropping from a speed, in r. p. s. of										
	55 to 50	50 to 45	45 to 40	40 to 35	35 to 30	30 to 25	25 to 20	20 to 15	15 to 10	10 to 5	5 to 0
A.	....	....	20	26	23	28	25	32	35	43	27
B.	....	20	20	19	24	25	27	30	30	38	30
C.	....	....	17	15.5	19.5	21	24	26	31.5	33	20
D.	....	....	15	13	12	13	13.5	24.5	53	51	26
E.	....	12	11	12	14	23	22	37	49	54	25
X.	....	14.7	16.7	17.0	18.9	21.8	22.2	30.4	40.1	43.8	25.5
Number of period.	11	10	9	8	7	6	5	4	3	2	1

Al (10). Cu (89.9). Mn (.1). No. 3.

Performance.	Time in dropping from a speed, in r. p. s. of										
	55 to 50	50 to 45	45 to 40	40 to 35	35 to 30	30 to 25	25 to 20	20 to 15	15 to 10	10 to 5	5 to 0
A.	....	8	8	9	9	9	9	10	10	10	9
B.	....	....	9	10	9	10	10	10	9	9	8
C.	....	....	....	9	9	10	10	10	10	10	9
D.	....	10	10	10	11	11	11	12	11	11	11
E.	....	....	....	....	9	9	10	10	11	10.5	10
X.	....	8.6	8.9	9.4	9.4	9.8	10.0	10.4	10.2	10.3	9.4
Number of period.	11	10	9	8	7	6	5	4	3	2	1

selves the year before. But these, it is believed, are due to the more leisurely manner in which the latter work in microscopy was performed.

Considerable uncertainty exists regarding the chemical combinations of metals. It is widely believed that SbSn exists. Also Cu_3Sn and $SbCu_2$. Indications in the work of Alder Wright have pointed to Bi_2Sb_3, $CuZn_2$, and $CuZn_4$. In the absence of more reliable data, it will be assumed that some such compounds exist, but the atomic proportions will be omitted. Thus all compounds believed to exist will be designated by writing the symbols without subscripts, as SbSn, CuSn, SbCu, etc. By so doing the writer does not mean to subscribe to the belief that the chemical compound CuSn exists or that AlCu exists, as some profess to believe.

It must also be remembered that we are here dealing with ternary alloys. Very great uncertainty exists as to just what happens in a given case when three metals are melted together and, after being mechanically mixed, allowed to freeze. The work of Alder Wright, as published in Professor Roberts-Austen's "Introduction to the Study of Metallurgy," is not complete enough to throw any light upon the cases here in hand. But generally, in the present investigation, one of the constituents has been given such a small proportion of the whole mass, that the alloy may presumably be regarded as a binary alloy.

In ideas of friction, hardness of the rubbing members comes largely into evidence. And in alloys, where it is expected that totally different physical substances will occur side by side, it is the *differences* of hardness that we look for largely. Thus it interests the investigator of friction to know whether or not there are in a given alloy hard grains embedded in a soft matrix, or soft islands surrounded by a hard network, or "gridirons" made of interstratified plates, soft or hard. The author has by two methods only been able to draw inferences about differences of hardness: (1) By the use of the sclerometer. (2) By observation under the microscope during the operations of polishing the surfaces before etching. The first kind of observation was found useful in the case of the "embedded hard grain" alloys, for it was found easy to detect deviations in the path of the diamond point where it had passed around, or run over without deeply scratching the hard grains. The second kind of observation was resorted to in a few such cases and generally confirmed the sclerometer tests. In the case of the "hard network" alloys, relief polishing by the second method, was the best resort. Whenever an alloy, after being polished carefully in relief, was found to have dark areas when examined microscopically, it was assumed that out of these dark areas there had been brushed a softer or else a weaker material.

When no means was at hand of knowing what differences of hardness existed, it was assumed that portions of the surface which behaved differently when treated with acid were of different constitution and therefore probably differed in hardness. As an example, Fig. 8 shows the photomicograph of an aluminum-copper alloy, in which magnesium is the third constituent. Relief polishing gave no evidence of differences of hardness, and neither did the the sclerometer. But when etched, large black islands formed on the surface. The planimeter shows that the islands constitute almost exactly one-half of the area. Neglecting the magnesium, it is evident that if this black portion is the chemical compound of aluminum and copper, it must be one in which the number of atoms of aluminum is very great, compared with the number of copper atoms; in fact, the disparity is too great to admit of the possibility of its being composed entirely of such a compound. The same may be said of the white area. If the alloy is a solid solution of copper in aluminum, it is a very heterogeneous one, and marked segregation has taken place where we should expect the opposite conditions of casting (the ingot was cast in a chill mould). It is at once seen that if either of the eutectics Al (67) Cu (33) or Al (46) Cu (54) had formed the area taken by it would not be nearly so large as one-half of the total area.

Thus we are at sea regarding the constitution and hardness, though we might say, "if the constituents differ, the hardnesses differ." But when we continue to examine this alloy in connection with others of similar constitution, we are somewhat enlightened.

The Aluminum Series—In Fig. 9 are shown the white alloys of copper and aluminum, resistance curves of which have been given above. The compositions of these differ little from that of Fig. 8, lately discussed, the latter being nearly the same as (b) of Fig. 9. But these were etched with HNO_3 instead of HCl. To illustrate more clearly the difference of appearances when differently etched, Fig. 10 shows (b) of Fig. 9 etched with HCl. The thin medial lines in the white network of Fig. 10 are not unlike the black lines of (b) Fig. 9, and we may reasonably conclude that they are the same. Something seems to have caused the acid to begin the attack on the aluminum crystals at their mid-points and has preserved from attack the outside portions near the black lines.

Despite this study in etching, the decision regarding hardness is still attended with uncertainty. Before etching, the polished surfaces of the four alloys were examined microscopically. At first no structure appeared visible on the surfaces of (a) or (b), and the larger straighter markings of (c) appeared as black blotches, but when (d) was put under the

Al (5). Cu (75). Mn (20).

Performance.	Time in dropping from a speed, in r. p. s. of										
	55 to 50	50 to 45	45 to 40	40 to 35	35 to 30	30 to 25	25 to 20	20 to 15	15 to 10	10 to 5	5 to 0
A.	....	....	....	10	10	9	10	9	11	10	9
B.	....	....	....	9	9	9	9	10	10	11	10
C.	....	....	9	10	9	9	10	10	11	11	9
D.	....	....	9	11	10	10	10	10	11	10.5	9.5
E.	....	....	....	....	10	10	10	10	10	10	8
X.	....	....	9.1	10.1	9.7	9.5	9.9	9.9	10.7	10.6	9.2
Number of period.	11	10	9	8	7	6	5	4	3	2	1

FIG. 8

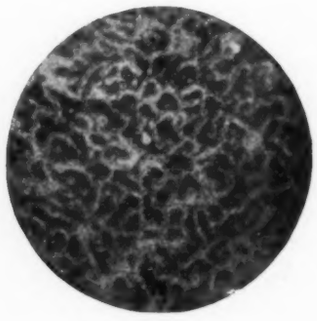


FIG. 10

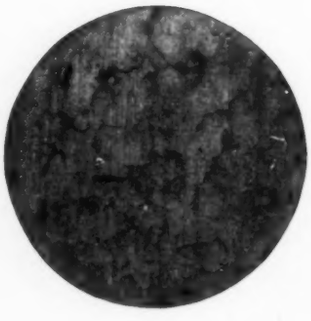


FIG. 9 A

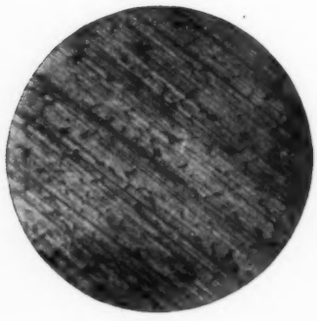


FIG. 9 B

FIG. 9 C

FIG. 9 D

AL (10). CU (89). MN (1). No. 2.

Performance.	Time in dropping from a speed in r. p. s. of										
	55 to 50	50 to 45	45 to 40	40 to 35	35 to 30	30 to 25	25 to 20	20 to 15	15 to 10	10 to 5	5 to 0
A.	....	....	10	8	10	10	10	10	11	11	10
B.	....	....	....	11	11	10	10.5	12.5	12.5	12.5	10
C.	....	....	10	11	10	10	10	10	10	10	8
D.	....	9	9	10	9	9.5	9.5	9.5	10.5	10	10
E.	....	....	....	....	8	9	9	9	10	9.5	9.5
X.	....	9.3	9.8	9.9	9.6	9.7	9.8	10.2	10.8	10.5	9.5
Number of period.	....	10	9	8	7	6	5	4	3	2	1

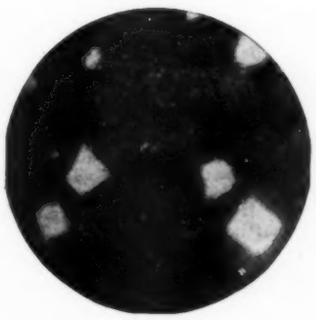


FIG. II A

FIG. II C

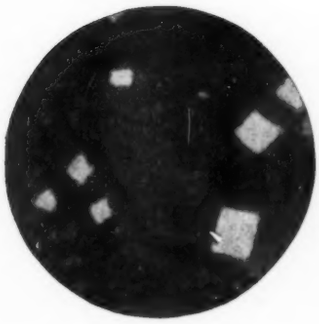


FIG. II D

FIG. II E

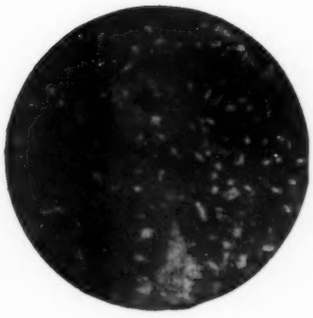


FIG. II F

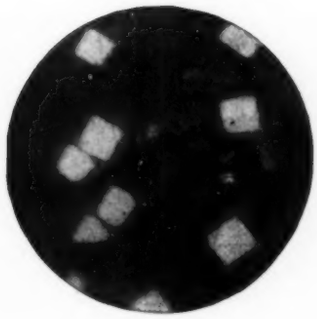


FIG. II G

glass," a faint white network appeared, which corresponded closely to the black lines in the etched view of (d), and which appeared to be in relief When the others were re-examined for this white network feature (a) showed very faint signs of such, but (b) did not, and the straight black blotches only characterized (c). It is believed from this that the black crooked lines, which show in all four alloys, are of the harder substance (possibly AlCu), and that the straighter black blotches of (c) are of a softer or weaker substance.

Excepting that we may attribute the last named feature to the antimony in the case of (c) there is nothing but conjecture about the effect of the third constituents of (a), (b) and (d). They do not seem to assert themselves excepting in (a) and (b), the resistance performances of which differ so markedly at high speeds

The Tin Series.—In Fig. 11 are photomicrographs of the six alloys of the Tin Series which contained bismuth. All of these are shown by the sclerometer to have hard white crystals, embedded in soft matrices. These crystals are of three types. (1) Nos. a, d and g have square white patches, and since these alloys have goodly proportions of antimony it may be concluded that these are cubes of the compound SbSn They seem much harder than the matrix which latter we must believe to be largely the pure tin. (2) Nos. (c) and (e) are seen to have long, white, slender patches, as well as small dots and chains of dots. (3) No. f has the same kind of small dots, but no chains or needles. The white crystals in c, e and f are harder than the matrix, so far as the writer is able to discover. These are probably CuSn.

Referring to the curves on the sheet marked "Tin Series," it has already been remarked that all alloys containing bismuth had the featureless endings at the *X*-axis. These curves are practically similar, and hence there is nothing in them to reflect the difference in shape and size of the crystals above remarked in the microstructures.

Below, in Fig. 12, are shown photomicrographs of the remaining three alloys of the tin series. All contain white squares, which we interpret to mean hard cubes of SbSn. No. (b) is Babbitt's metal. It has white needles (presumably CuSn) in addition to the cubes of SbSn. Nos. h and i, which contain zinc as the third constituent, seem to have no hard granules except those we have called SbSn. It is seen that with Nos. b, h and i we might attribute the similarity of curves h and i, and their dissimilarity to (b), to the difference in microstructures, viz., the absence of needles and dots among the white cubes h and i. But notice that i is magnified nearly doubly as high as h, and that even then its cubes are not nearly so large. Actually, then, the cubes

of i are but dots compared with those of h. The *size* of the granules seems to have no reflection in the *shape* of the curve. Hence we can scarcely attribute the dissimilarity of b to h and i to the small dots of the former.

The great question is, to what *shall* we attribute similarity of curves, so that our conclusions may be confirmed by microstructure. Looking at the nine curves, and the nine structures of the tin series, as a whole, all have hard grains embedded in soft matrices. But the curves present many differences in shape. (1) So that hard grains so found are not themselves sole causes of any peculiar resistance variation. (2) Also, the size of the grains seems not to determine this resistance variation. (3) Nor does the shape of the grains themselves seem to have the determining effect on the shape of the resistance curve. But let us now notice those constituents which we have not mentioned in discussing the structures, because there seemed no good reason for their appearance as crystals, such as have been mentioned as the features of the microstructures. These may be called the "silent constituents," and are exemplified in the bismuth of a, c, d, e, f and g, and the zinc of h and i, which do not "show up" in the structures. Upon failure to assign reasons, obtainable from structure, for peculiarities of curves, may we attribute the latter to the unseen effect of the "silent constituents?" The remarkable similarity of all curves of alloys containing bismuth and of those containing zinc lend considerable weight to this otherwise purely circumstantial evidence. We may say at this time that we have here part proof, and as yet no refutation, of some such law as the following: *The effect of constituents which form hard crystals is constant; the effect of "silent constituents" varies with the speed.*

Looking at the photomicrograph of the alloys whose curves have been given on the sheet entitled "Miscellaneous Alloys," we have the structural features of "white metal" and of three yellow alloys of aluminum and copper. See Fig. 13. In the white metal we detect small squares, and seeing that the composition admits that possibility, we may say that these are cubes of SbSn. These crystals are comparatively few in number, so that the structure would indicate a resistance performance not very different from that of pure lead. This is seen to be the case when curve 1 of "Miscellaneous" sheet is compared with the curve of lead on the sheet of pure metals. Here is more verification of the belief that crystals of chemically combined metals embedded in a softer matrix do not affect the manner in which the resistance varies with the speed. A question of great industrial importance is whether or not the crystals greatly affect the actual value of the resistance in the constant manner intimated

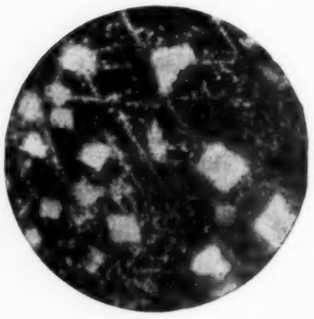


FIG. 12 B

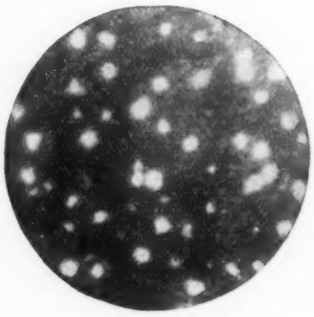


FIG. 12 I

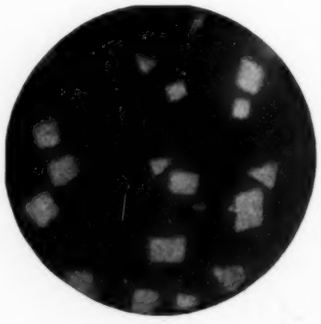


FIG. 12 H

above in the discussion of the tin series. Comparing the curves of "white metal" and pure Pb, by the scale of times, such belief is confirmed, for the total running time of "white metal" was 252 seconds, while the performance of pure lead was 332 seconds in duration. The effect of the crystals seems to be just what might be expected, *i. e.*, that of increasing the resistance as a whole.

The microstructures of the "aluminum bronzes" are of a totally different kind from any heretofore presented in this account. When etched these specimens all showed remarkably well defined crystals, closely packed together, without any well ordered arrangement, and differently tinted by the acid, making the surface very mottled in appearance. A very noticeable feature was the gridiron-like appearance of many of these crystals themselves. Each one seemed to be a stack of plates set edge on to the surface, but with direction peculiar only to that crystal. No. d shows this best, though the resemblance can be traced in c and to some extent in b. None of these shown exhibit the "gridiron" feature quite so well as it appears in the microstructure, without magnification. Aside from the faint resemblance noticed above by the aid of the microscopic observation, there is little of similarity to be noticed in the microstructures. Yet the frictional performances were almost identical. So that here we have a claimant for the position we have heretofore assigned to the "unseen constituents." Is it then microstructure only or, in terms of friction, the lower orders of asperity which determine the resistance variation? Now these lower orders of asperity could hardly have been the cause of the "white metal" pure lead similarity of performance. Again, the "silent constituent" was the same in all three of these latterly discussed alloys, and therefore still have as much right to the importance which has been attached to them as they had before.

Conclusion.—We may now apply the knowledge gained from the study of the resistance curves and the microstructures to the three questions named in the first part of this paper. They were as follows: (1) The law of variation of the amount of friction with the velocity of sliding. (2) The theory of Charpy and others regarding the function of the hard grains and of the plastic ground-mass in the microstructure of alloys. (3) The theory of Prof. Goodman, having to do with the atomic volumes of the metals employed in bearings.

(1) A glance at the results shows that a "law" could be made to apply to all of these cases at once only in an extremely general way, if at all; and that, when we consider details, nearly every affirmation in such a law would be contradicted by some of the results, leaving almost nothing in the nature of a general law of variation, applicable to all alike. In short, an alloy's resistance performance seems to be peculiar to itself, although there are often partial similarities.

Henceforth our thought may take two or more different channels. We may try to explain matters by the aid of the microstructures (which should include the "silent constituents"), or we may attempt to account for the variations noticed upon some purely mechanical, or perhaps the better expressed, accidental conditions. The microstructures, compositions, ets., having been discussed above, let us see what we may do with abrasion as our light. It is admitted that generally abrasion is greatest at higher speeds, as we should expect. The upper portions of the curves would generally support an abrasion theory of the variation. There is also support for this in the fact that the

softer metals show greater changes of resistance in falling down from the higher speeds. But the latter statement is controverted very largely by comparisons in this detail. Take the pure metals, aluminum, lead and copper; aluminum, which is second in hardness, has very little variation, while copper, first in hardness, has nearly as much of this peculiarity as the very soft lead. As a last argument in support of the influence of abrasion, we may cite the curves of the aluminum-bronzes. These were the hardest of the alloys, and show the least—practically nothing—of variation. So that, for these instances, where there was least abrasion, there was least of higher-speed variation of resistance.

At the lower ends of the curves there are two distinct peculiarities. Fourteen of the twenty curves are decidedly convex upward, and the remaining six just as decidedly straight or convex downward. Abrasion can hardly explain the difference. Not only can it not explain the upward convexity of the fourteen, but that peculiarity operates against such a theory. And meantime the straightness of the other six lends absolutely no support to an abrasion explanation. Also, against such an explanation there may be cited numerous small differences, noticed at high speed, between alloys physically very much alike. As an example of this we have the marked difference at the high speeds between curves 1 and 2 of the Al series. Moreover, in general, the peculiarities of the curves were most marked when the average resistance was least, *i. e.*, when the total running times were longest, which fact operates effectively against the soundness of the abrasion argument, for abrasion at once increases the resistance.

On the other hand, it appeared that mechanical imperfections, microscopic structural features, hard crystals of chemical compounds and other "foreign" effects, which make up the *lower orders of asperity*, had a rather constant influence on the resistance. Also, that groups of alloys could be formed in which peculiarity of performance went hand in hand with one of the three constituents. This constituent was not noticed in the microstructure and was called the "silent constituent." Accordingly it may be inferred that such constituents affect the grouping of the atoms, or even the minute crystals, in such a way as to determine the feature of the *higher orders of asperity*.

On the whole, it does not seem at all improbable to the writer that the lower orders of asperity exert a nearly or quite constant resistance, or that the higher orders exert resistances varying according to the microstructure, although it may also be true that the variations noticed are resultants of two or more effects, either of which might be constant if taken separately, but that under varying conditions of speed at points more and at other points less of each effect enters into the resultant.

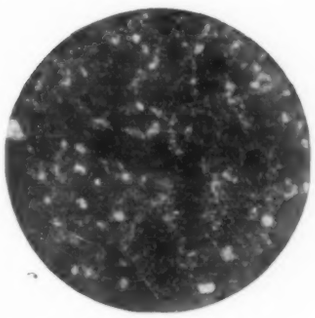


FIG. 13 A

FIG. 13 B

FIG. 13 C

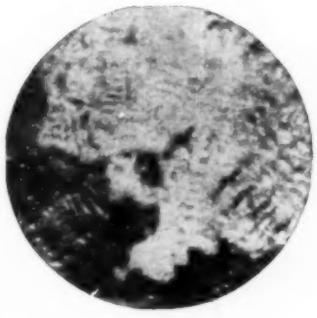


FIG. 13 D

(2) Charpy's conclusion seems to be that it is the hard grains that contribute to the alloy whatever anti-friction quality it possesses. The results of the present investigation seem to the author to work against that conclusion. Notably so in the case of pure lead and the "white metal," which is largely lead, but has the hard cubes of SbSn. While these results are not intended in any sense to be regarded absolute measurements of resistance, still it may be well to note the performance of the pure metals, aluminum, copper and lead, in comparison with alloys of those metals. Aluminum ran longer than any of its alloys; and so did lead; likewise copper performed with much less resistance than did any of the yellow alloys of aluminum with copper. The only conclusion which can be come to is that the foreign substances introduced into an alloy as a result of the formation of isolated hard crystals tend to increase the resistance, and as noted in (1) above, in a somewhat constant manner.

(3) The conclusion of Prof. Goodman was that if the third constituent of an alloy were a metal of high atomic volume, the resistance was diminished, and if of low atomic volume, it was increased. The observation of the writer that these third constituents when "silent" seem to have a great influence upon the variation of resistance with the speed, leaves the way clear for such a conclusion as Goodman's to obtain: since we may assume that the atomic volume of the element effects the higher orders of asperity.

In the actual results, look at the curves of the *tin series*. Comparing 1 and 2, it is seen that in 2 the bismuth of 1 has been replaced by copper. The result is slightly in favor of Goodman's theory, for the atomic volume of Bi is 21.1 and (1) ran 285 seconds, while that of Cu is 7.2 and 2 ran 248 seconds. But the reverse result is obtained when in 6 we replace copper by antimony (atomic volume, 17.9), obtaining 7, which showed greater average resistance. So that these results do not support Goodman's. But it is realized that what is now offered can only be regarded as meager in its power to refute or confirm.

During the time of the Paris Show a service of automobile omnibuses was run between the Bourse and the Grand Palais (the show building). The service comprised nine buses, all of different make. The round trips took about forty-five minutes, so that a five minute schedule from each end could be maintained.

Because accidents will happen in the best-regulated families, is no excuse for taking steps that you know are likely to bring one about.

CORRESPONDENCE

Discussing Phases of Machine Design and Construction

A Fixture for Cutting Oil Grooves in Spindles

While this device may seem rather primitive in its principle and our method of applying it rather crude, nevertheless it gives us just exactly what was required. Formerly all oil-ways were cut in the bearing, which was always a tedious operation. It was essential for the bearing to have a copious supply of oil and the time and expense of cutting an oil groove in the bearing with a capacity great enough to meet this condition was excessive. Finally it was agreed to cut the groove in the spindle, but it was some time before we struck a scheme which would do this satisfactorily. The device here illustrated was devised to do the job. This fixture was originally intended as an experiment and was supposed to be used temporarily, the idea being to make another fixture for permanent use if it proved to be a success. However, the experimental device was as

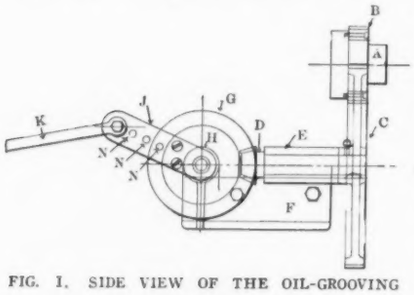


FIG. 1. SIDE VIEW OF THE OIL-GROOVING FIXTURE

efficient as could be desired and we concluded that it would be foolishness to make another fixture to replace it. After we decided to cut the groove in the spindle the question arose, what form of groove will give the best efficiency? It was finally decided that an endless-spiral groove running almost the full length of the bearing would be nearly ideal, for the direction of rotation of the spindle would tend to keep the oil always moving and it mattered not in which direction the spindle was rotating. The problem of cutting it was not an easy one and the device here presented is the solution.

Fig. 1 is a front view of the device used and Fig. 2 is an end projection. *A* is the cone pulley at the end of the spindle ordinarily used for driving the feed shaft on the lathe. The gear *B* was bored to the diameter of the middle step of the cone over which it fits. It is fastened to the pulley with two fillister-head screws which run through the gear and screw into the side of the large step of the cone. This gear meshes into the gear *C*, which is keyed and clamped to the pinion shaft *D* as shown. This shaft takes its bearing in *E* on the bracket *F*. As will be seen the bevel pinion is turned solid on the

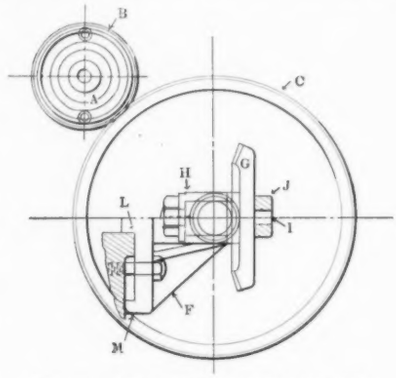


FIG. 2. END VIEW OF THE FIXTURE

shaft, forming a shoulder which thrusts against the bearing *E*. This pinion meshes with the large bevel gear *G* which is supported by the shorter bearing *H*. This gear was cast with a long boss which was turned to fit the bearing in the boss *H* and form a shoulder for the washer and nut. The threaded portion for the nut is solid with the gear as is the pin *I*. The crank *J* was drilled to fit over the pin *I* and was clamped solidly to the gear *G* with the two screws shown. The rod *K* pivots on the end of the crank *J* as seen in Fig. 1; the other end is fastened to the carriage of the lathe. The bracket *F* rests on top and is clamped against the side of the guide as at *L*. The heel *M*

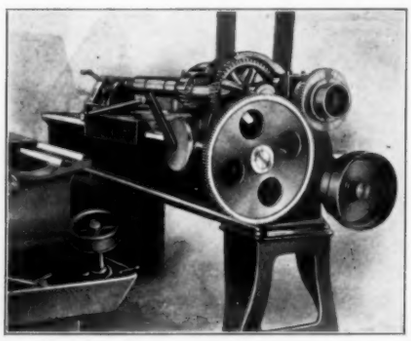


FIG. 3. FIXTURE APPLIED TO THE LATHE

was purposely made narrow so that very little dressing would be necessary to have it bear properly against the unfinished side of the lathe bed. The manner of operating the fixture is obvious. The crank being driven from the spindle through the gears gives the carriage the correct motion which makes the required spiral on the spindle. The bevel gear *G* has a ratio of six to one with the spindle, thus giving three revolutions of the spindle for the length of the work and three on the return. The crank *J* was made long enough to groove our largest spindle. The holes *N* were correctly located for the different shorter spindles, the rod *J* pivoting in these holes, which decreases the travel of the carriage. At first we intended using a drag tool to secure ideal cutting conditions; but we were doubtful about it always following in the same path, which of course would be necessary to secure a clean-cut groove. In experimenting, a round-nose tool with lots of cutting clearance held in an Armstrong toolholder was used with very satisfactory results. While we know that this is by no means ideal, yet the finished spindles

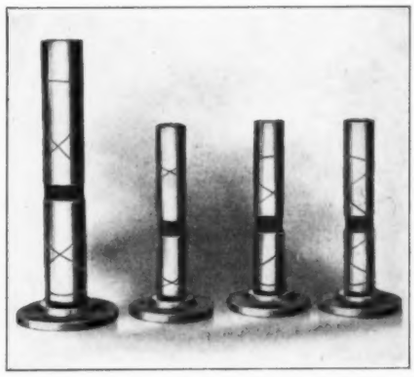


FIG. 4. SOME OF THE WORK

testify that it is good enough for the job.

The permanent fixture which was to follow this one after it had passed the experimental stage was laid out with the gear *C* meshing with the back gear of the lathe and instead of using bevel gears *G* and *D* a worm and worm wheel were to be used. It happened, however, that we had regular gears which, if slightly modified, would make the gears *B* and *C* and thus gear direct from the spindle. The bevel gears were more cheaply made than the worm, but could not be used if we geared from the back gears for the reason that it threw the crank *J* too far below the guides. The experimental device is cheap and so good that we shall not change it and it possesses the additional advantage

of being more convenient. When not in use the gear *B* and rod *K* are removed and the remainder of the device is left intact as it interferes with nothing. With the other device this could not be done, as the gear meshing with the back gear was fixed to the bracket and thus the entire device would have to be removed.

Fig. 3 is a photo of the lathe with the device attached and the spindle in place. Fig. 4 shows two sizes of spindles with the grooves cut. The wide groove in the center of the spindle serves as a chamber for the oil and when in place is directly under a glass oil cup of large capacity. It will be noticed that the place where the grooves cross is nearer the point of return at the bottom than at the top. It puzzled me at first to know what caused this condition. I afterward learned that a crank does not give the throw on each side of the center with the same ratio of speed, a problem that engine builders had encountered years ago. L. F. B.

A Spherical Turning Fixture

The accompanying illustration shows a fixture designed to finish the part *f* to a fair degree of accuracy. It is fitted in the cross slide of the carriage of an engine lathe with the plate *a*.

A and *A* are supports carrying dovetailed slides with tool posts and stops. The slides are operated by levers *B* and *B*, and held fast by binder screws *c* and *c*.

D is a worm wheel on which the supports *A* and *A* are mounted, the wheel being driven by the worm *E*, having bearings *e* and *e* to take the thrust.

A shaft through the worm is connected with a universal joint *F*, supported in a bracket at the rear of the lathe, and actuated by one of the change gears.

One cutter is used as a rougher, the other as a finisher, the lathe being reversed for one operation. GERALD.

Drilling Holes in Buttons

I was rather inclined to agree with your correspondent who divided the AMERICAN MACHINIST into two parts, making Osborne one of them, but on reading Dixie's communication at page 381, concluded if he was not the other half he was well on toward it.

What a fund of information, what a world of experience and what cute dodges he has set forth in his various communications!

Drilling eight holes at once in eight buttons rather than trying to drill four holes at once in one is perhaps no more than applying a principle that has been used in some turret operations; but whether it was or not, it was worth telling.

He mentions indexing for the four holes, from which I infer the spring chucks were rotated one-fourth of a revolution after each hole. If that was his way I want to go him one better.

Assume the eight chucks were set in a bar long and wide enough to receive them, say one foot long by an inch and a half wide, the bar to have straight sides and square ends and surrounded by a plate secured to the platen of the drill-press, with an opening in it as much longer and wider as the holes were to be apart. That is to say, if the holes were to be ⅛ inch apart, the opening in the plate to be 1⅝ inches wide by 12⅛ inches long.

With this rig it would have been only necessary to hold the bar containing the chucks first tight in one corner and drill the first eight holes, then move it to the next corner and drill the next eight, and so on the four corners of the plate properly and accurately indexing the four holes in every button without gears or mechanism.

The plate would need to be blocked up above the drill-press table to prevent the chips from getting in the corner to prevent the chuck bar from coming to place.

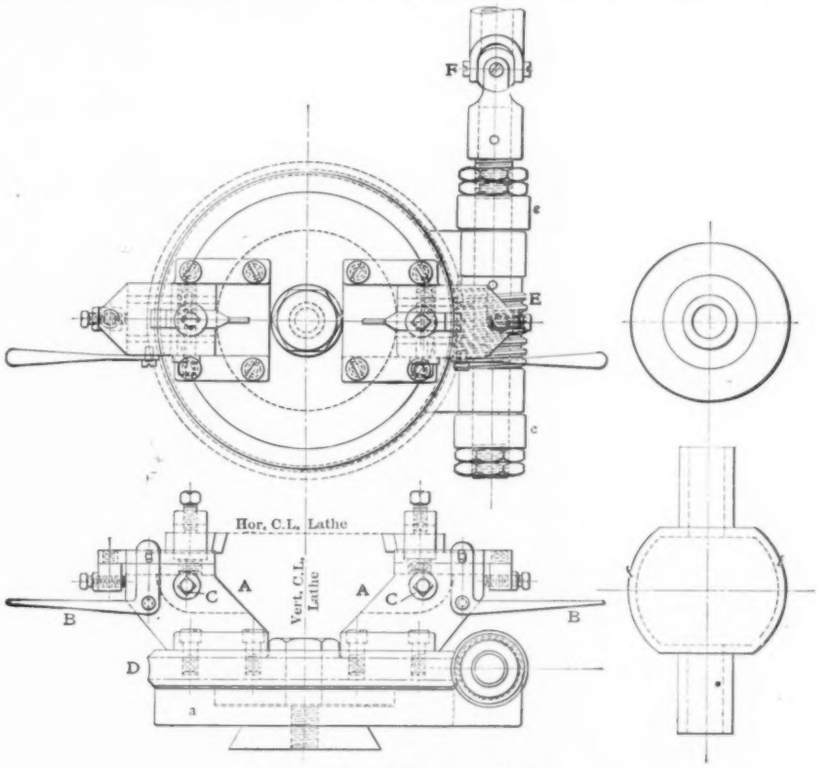
ONE OF THE OTHER PART.

Force Necessary to Strip Work from Punches—Comparative Friction on Punches with and without Clearance

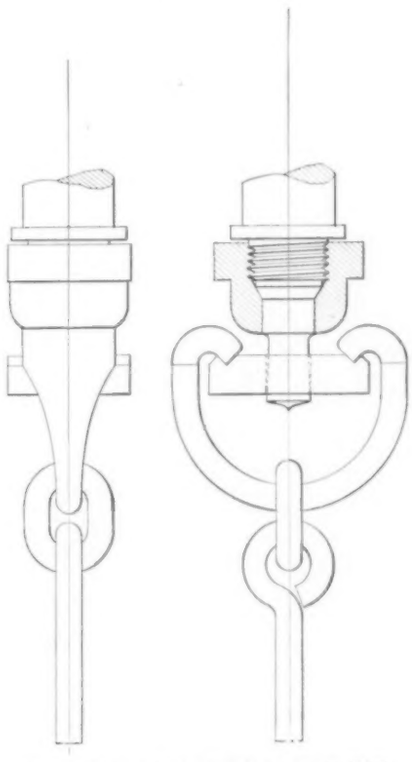
Nearly all manufacturing concerns, or at least all who do much punching of steel and other metals, have their own standards for punches and dies, but very often, unless they have made actual punching and stripping tests, it is a question what amount of taper to give the punches.

As it is a fact known to anyone doing much punching, that the largest per cent. of punches are broken in stripping, it becomes a question of stripping, which determines the amount of taper on punches.

It is the idea of some, that if a punch is made tapered, it gives the metal a chance



A SPHERICAL TURNING FIXTURE



STRIPPING THE WORK FROM THE PUNCH

to close up around the small part of the punch while the punch is through, and that if a straight punch is used, the metal around has no chance to close. This, of course, is what determines the amount of pull to withdraw the punches.

Upon this basis we concluded to make some tests of stripping with differently tapered punches. Accordingly we turned up three standard 23/32-inch punches, one with a taper of 2 degrees to the center line, one with 1 degree taper and one straight. Also cut off three pieces of 5/8x2-inch low-grade machinery steel, 2½ inches long, and cut as shown.

One standard screw plug shank was used, which fitted the punch press, this shank being put into the press and used for each of the punches, which were held by couplings, as shown. Each punch had its own coupling, and when taken to the testing machine, the same plug was used, being left in the machine and each coupling and punch in turn being screwed to it.

The tests were made on a 50,000-pound Riehlé testing machine. The results were as follows: The first punch, 2 degrees taper, stripped at 550 pounds; the second punch, 1 degree taper, stripped at 780 pounds, and the third punch, the straight one, stripped at 2000 pounds. Both of the tapered punches were loose in the steel pieces, and did not tighten until withdrawn about half way through the steel; but the straight punch was tight in the steel piece, and projected through about ⅛ inch, just the distance through that it was punched.

This shows without doubt that tapered punches strip more easily, but there are other conditions to contend with. A tapered punch will not last as long as a straight one, because it cannot be ground very much without losing its size; in fact, theoretically it cannot be ground at all; whereas a straight punch can be ground indefinitely, without losing its size.

Of course in actual practice the grinding feature is not as important as the breaking one; therefore a happy medium should be taken for the taper of punches, depending upon the conditions and the nature of the work in each different class.

H. D. MacDonald.

Some Hack-Saw Troubles and Their Remedies

The accompanying sketches are intended to show some hack-saw troubles and also how we remedied them.

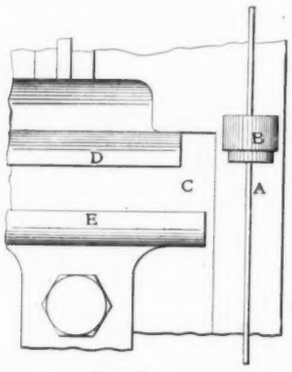


FIG. 1

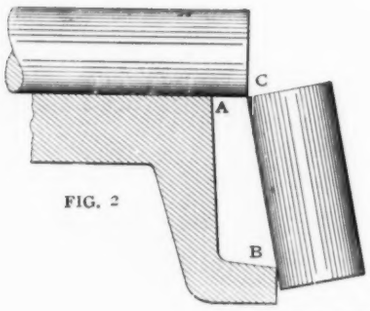


FIG. 2

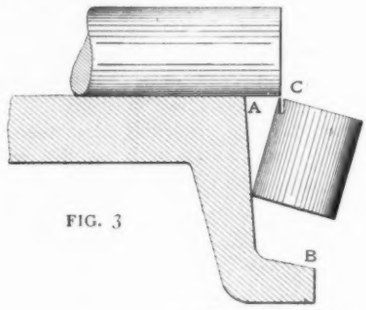


FIG. 3

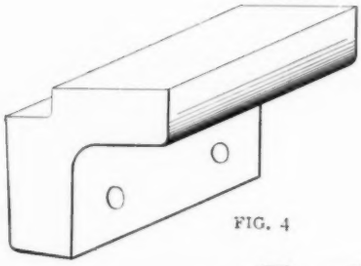


FIG. 4

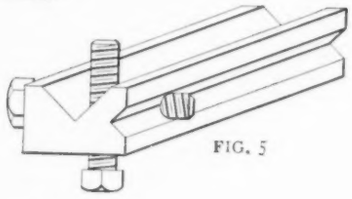


FIG. 5

HACK-SAW TROUBLES AND REMEDIES

Fig. 1 is a plan view of the vise part of an ordinary hack saw, *A* being the saw blade, *B* the guide, *C* the table where the stock is placed to be sawn; *D* and *E* are the back and front jaws respectively.

The distance from *A* to *C* is ½ inch, from *A* to *D* 1 inch and from *A* to *E* about ⅝ inch.

The distance from the saw to the table is shown in Figs. 2 and 3. The shaded part is part of a cross section of the table with a piece of stock thereon. The distance from *A* to *B* is about 3 inches. As soon as the blade gets worn a little the tendency is for the stock to bend across the saw cut, when it gets nearly through the piece, then, if the piece being sawn from the bar is longer than 3 inches a cut is made as at *C*, Fig. 2, or if the stock is shorter than 3 inches a cut will be made as shown at *C*, Fig. 3. The remedy we adopted was to bolt a piece of gray iron, shown in Fig. 4, to the frame of the saw to support the stock. This was little trouble and saved a good deal of waste. Another inconvenience which we found and overcame was that very short pieces of stock could not be held in the vise. For instance, take a piece of stock 2 inches long, to be sawn through the center. The distance from the saw blade to the back jaw of the vise is 1 inch, leaving nothing to hold it by. Take the same piece and it is required to saw a piece ½ inch long from one end, this leaves ½ inch to hold it by, and means that a similar piece of stock must be put in the other side of the vise to get a hold.

We took two pieces of gray iron 6 inches long, about 1x1¼ inches. These were planed parallel, and in the one, two Vs were planed and two screws put in as shown in Fig. 5. The screws were an easy fit so they could be adjusted by hand. With these parallels we could hold stock, however short, right up to the saw blade itself; in fact we have taken a piece of stock 1 inch diameter, ½ inch long and sawn it through the center.

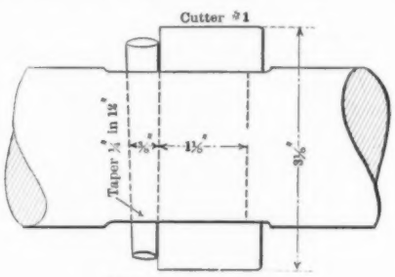
Cyclo.

England.

Boring-Bar Cutters

I was much interested in the article by "Draftsman," at page 351, on the above subject.

Some years ago I built a number of machines, whose gear bearings had to be bored when the frames of the machine were bolted in place. The boring had to be done with a bar running in jig plates, one on each end and one in the center of the machine, and driven by a pulley fastened on to the extreme end of the bar and belted to the main shaft. The bar itself was 2 inches diameter, and about 6 feet long, made of tool steel, and carried four cutters, all four cutting at once. The quantity of stock to be removed required three cuts to finish the job, and consequently required three cutters for each mortise in the bar.



BORING-BAR CUTTER

These mortises were lettered *A*, *B*, *C* and *D*, and the cutters that fitted in the different mortises were numbered A-1, A-2, A-3, A-4 and B-1, B-2, B-3, B-4, etc. This rig bored the frames for over one hundred machines. There were seventeen

holes in each frame, so that each set of three cutters finished seventeen hundred holes. These holes were practically interchangeable. A slight difference was perceptible, owing to the cutters wearing; but as the holes were to be fitted with bushings, the slight variation did no harm.

I believe the way of holding the cutter in the bar, as shown in the sketch, to be the very best and simplest way to accomplish the purpose. The gib used by "Draftsman" is, in my opinion, superfluous, and the extra length of the slot only tends to weaken the bar. There is no better method than the one he employed to cut the slot in the bar; that is, if the slot is to be exactly central with the bar. I rough out the stock by drilling and milling, and finish by hand, with the aid of a vernier caliper, to get the slot exactly central. I flatten the bar where the lips of the cutter rest. I notice that "Draftsman" has the cutter lips fitting on the round surface of the bar. This will, of course, bring the cutter central; but as the bearing is small, it will soon wear the bar. The flattening can be milled fairly accurately, and then corrected by filing. I turn all cutters to size when keyed into place in the bar, and after backing off, harden the cutting ends only, as they are apt to shrink if hardened all over. I tried to turn these cutters in a cutter arbor, the slot in which was (or was supposed to be) a duplicate of the one in the bar, but I had to give it up, as the cutters would measure just a *little* different than when turned in the bar itself. Double-end cutters will do very good work, and can be made accurately enough for ordinary practice, but they cannot be made so they will be absolutely interchangeable, and so that both edges will always do their share of the work, especially when taking a finishing cut, and for very exact work I always use as stiff a bar as possible, and a single-end cutter.

Small bars should be made of tool steel, with ends turned down a trifle to receive a driving dog. The centers should be made large, and the ends of bar recessed and hardened before finishing to size.

I have described at length the method I used, on account of the large amount of work it accomplished, and that without difficulty or annoyance. These tools were made in 1886, and as the concern using them has never been able to find anything better, they are in use at the present time, and doing good work whenever called upon.

COMMON SENSE.

Stamping Work in a Shaper

While working in a job shop where we had to do anything and everything that came our way (sometimes the customer too), I once had to make several hundred brass pieces, as shown in Fig. 1. Each of these had to be stamped "Pat. Applied For."

This would have been a difficult job to do by hand, so I began to look for a quick and accurate way out of it.

We had a shaper that was not working that day, so at it I went, and in less time than it takes to tell, I had two pieces of cold-drawn steel *A* and *B* fastened in the

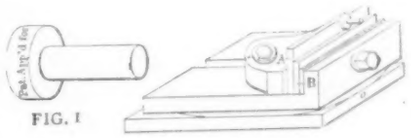


FIG. 1

STAMPING WORK IN A SHAPER

shaper vise, forming an angleway in which to place the work as shown in Fig. 2. Then fastening the regular hand stamp in the tool post, I soon had adjusted to give the proper impression. The machine was then started, and allowed to run continuously, it being only necessary to hold the pieces in position, as shown in the sketch. Each stroke of the machine rolled the work between the stamp and the piece *B* as nicely and as quickly, or perhaps more quickly, than could have been done in any other way.

Philadelphia, Penn. J. E. P.

An Improved Method of Punching Work by Confining it in a Hardened-Steel Jig

Ordinarily a punched hole is not smooth, so it is common practice, where a smooth, true hole is desired, to ream the holes

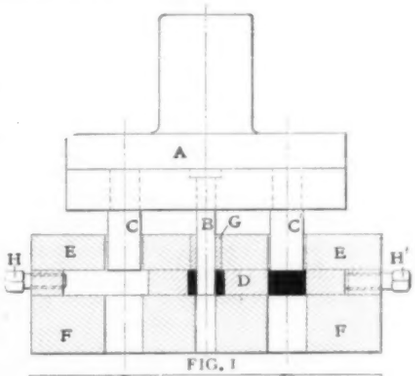


FIG. 1

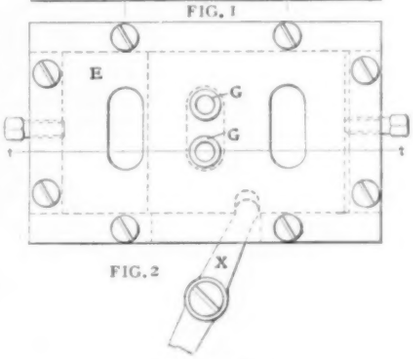


FIG. 2

THE FIXTURE

after they have been punched. While this may be necessary in some cases, it is not so in all, for I have seen punched holes that were far superior to drilled holes, and even superior to reamed holes, for accuracy of size and smoothness of finish. To accomplish this, the hole in the die must be very near the same size as the punch. The closer the fit the smoother the hole will be. Of course the punches will not hold their edge nearly so well where they are made close in this manner, as they will where more clearance is allowed, for there is always the likelihood of the punch springing a little to one side or the other, and striking the edge of the die. This is nearly always disastrous to either the punch or the die, but with a die made on the principles described in this article, the likelihood of the punches springing is reduced to a minimum on account of their being guided by hardened-steel bushings, which are placed directly over and as close as possible to the work being punched. It was found that this punch and die would work a remarkably long time without being ground, and the work turned out was superior in every respect to the work formerly turned out on the drill press, where the pieces were drilled and reamed.

One reason for this is that it is very hard to design and make jigs for drilling and reaming that can be kept perfectly free from chips and dirt so that every piece can be put in and held exactly in the same position. In the punch press we have no shavings or chips to contend with, although there is sometimes a sort of metallic powder which accumulates, and by getting mixed with the oil sometimes causes trouble.

The pieces punched with this fixture were chain blocks ½ inch thick, cut from cold-rolled stock.

Fig. 1 shows a cross-section through the die on the line *t t* of Fig. 2. *A* is the punch holder, *B* one of the punches; *C* and *C'* are the punches used for forcing the work into the confining plate *D*. In the stripper *E* are the hardened-steel bushings *G* which act as guides for the punches. *F* is the die, *H* and *H'* are adjusting screws for the plate *D*. The holes in this plate *D* are just the size and shape of the pieces to be punched. The pieces are forced into them so that they cannot spread out of shape while being punched. The drawing shows the punch at its lowest point. The punches *B* have passed through the block being punched, and the punch *C'* has forced another block into position in *D*.

The operation of the fixture is as follows: We will suppose the press ram to be at the highest point. In the left-hand hole of the plate *D* we have a finished block, and in the right-hand hole a block ready to be punched. We will now shift the plate *D* to the left. This is done by means of the lever *X* shown in Fig. 2, which brings the right-hand hole in the plate *D* in correct position under the punches *B*, and the left-hand hole under the punch *C*. We now drop another block into the left-hand hole in the strip-

per *E*, which should be a nice easy fit for the blocks. As the punch descends, the punches *B* will punch the holes in the block under it, while the punch *C* will force the block, resting in the hole in the stripper *E*, down into the left-hand hole in the plate *D*. As the new block goes in it will, of course, force the finished block down through the hole in die *F* into a box below. When the punches ascend and stop, the same operation is repeated, this time shifting the plate *D* back to the right again.

This fixture must be made very accurately. The plate *D* should slide back and forth easily, and still be a close fit. By adjusting the screws *H* and *H'* at the ends of the die, any inaccuracy there may be in the plate endways can be compensated for. The plate *D* should be just a little thicker than the blocks to allow for rounding the upper edge of the holes in *D*. If this edge is left too sharp, it will cut a shaving off the block as it is being forced in. The stripper should be firmly doweled to the die; great care should be taken to have the holes in the bushings *G* directly in line with the holes in the die, and they should fit the punches very snugly, so there will be very little danger of the punches striking the edge of the die. On this more than on anything else depends the length of time a punch and die will run without being re-ground. This also makes it easy to set this die correctly, which is very important when there is so little clearance between the punch and die.

In grinding the punches care should be taken to have *C* and *C'* just the same hight. The press must be adjusted very closely, so when a block is forced into the plate *D* it will just come flush with the bottom of the plate. If it goes a little too far, the block will catch on the edges of the die, and if it does not go far enough, it will not force the punched block out.

The blocks punched with this fixture were ½ inch thick, while the punches were only ⅜ inch diameter, and, so far as I know, they never broke a punch. This speaks well for the idea of guiding the punches through a bushing. It is something on the principle of driving a needle through a board by first forcing it through a cork, which acts as a guide, and stiffens it.

Pueblo, Colo. R. EARL WEINLAND.

Jig for Milling and Drilling Automobile Cylinders

The jig shown herewith was designed for milling the induction and exhaust branches on a petrol-motor cylinder of 4-inch bore x 4½-inch stroke, and also for drilling two stud holes in each branch. A side elevation of the cylinder is shown in Fig. 1. *A A* are the two faces to be operated upon, and are at an angle of 45 degrees to the center line. Fig. 2 is a plan of these faces.

In Fig. 3, *B* is a gray-iron angular base accurately planed on top and bottom, and also on the front to the correct angle. A ⅞-inch hole is then bored at right angles to the front to receive the plug *C*, which is 1 inch diameter on the front end and driven tight into the base up to the shoulder. Another hole, ⅜ inch diameter, is bored exactly parallel and in a perpendicular line with *C* to receive the locating pin *D*, which is a good sliding fit in the hole.

The cylinders are first put in a turret lathe, chucked by the bottom end, and faced straight on the five faces *E, E*, and *F*, Fig. 1. The four outside bosses *E* are to screw the studs into which secure the valve covers; the center one is for the water pipe for cooling the cylinder, and has a hole bored 1 inch in diameter. The valve-spindle holes are next bored with a plate jig on a drilling machine, after which the faces at *A* are ready to be machined on a vertical miller. The overhanging plate *G* is removed from the jig for the time being, and the cylinder placed on the plug *C*, which fits in the hole bored in the cylinder at *F*. The locating pin *D* is then inserted, and the cylinder twisted into position, when the pin will slide into the valve-spindle hole, and hold the work firmly in position, with one face *A* free to be milled. The clamping plate *H* is then slipped over the end of the cylinder liner, and pulled up against the face *I*, by the two swinging bolts *J*, which fit in the slotted ends of the clamp plate.

When one face has been milled the nuts are slackened and the bolts swung back, the locating pin *D* withdrawn and the cylinder turned round, on the plug *C*, half a revolution, when the locating pin is again inserted into the next valve-spindle hole. The cylinder is then clamped again and the milling finished, both the faces being exactly the same hight from the center, which is most important.

With this fixture 15 cylinders per hour can be milled. We use an inserted-tooth milling cutter with high-speed steel teeth, a table travel of 3½ inches per minute, and a cutting speed of 60 feet. For drilling the four stud holes, ⅜ tapping size, the overhanging bushing plate *G* is fitted on as shown, being located by the tongue in the center, and held by two 7/16 inch fillister-head screws. The cylinder is secured to the jig in precisely the same manner as for milling. AUTO.

Coventry, England.

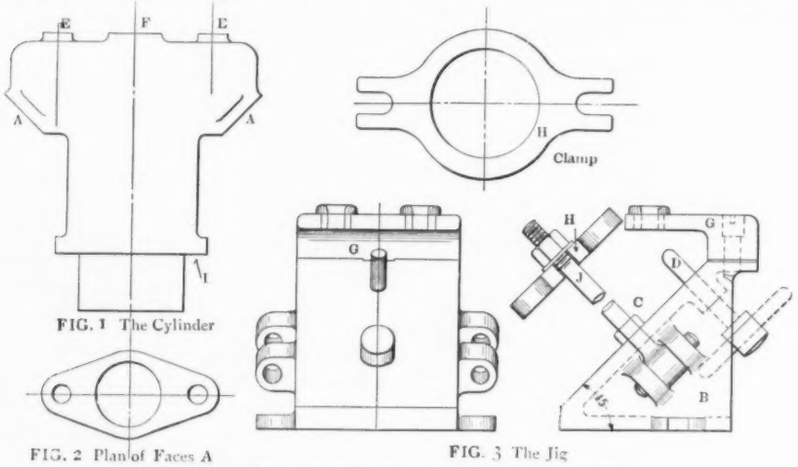


FIG. 1 The Cylinder

FIG. 2 Plan of Faces A

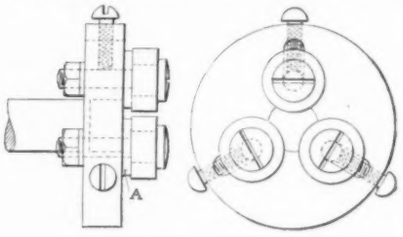
FIG. 3 The Jig

JIG FOR MILLING AND DRILLING AUTOMOBILE CYLINDERS

An Adjustable Nurling Tool

The accompanying drawing shows a tool I devised for nurling the ends of iron bobbin cores, preliminary to fixing hard-fiber rings thereon. It was made adjustable, to take various sizes of work. The body of the tool is of machine steel, the shank being made to fit in the turret holes, and also in a lathe chuck. The enlarged portion of the body carries 3 nurls of similar size and pattern, which are mounted on shouldered screws. These screws project through radial slots in the face of the tool, thereby allowing the nurls to be adjusted to suit the work. When they are correctly adjusted, and the screws on which they are carried tightened in place, the button-head screws are tightened down onto the shoulder screws to prevent the nurls creeping under the pressure of the cut. The length of the shoulders is sufficient to allow the nurls to rotate freely when the screws are tightened down on the washer *A*. The center of the shank is bored out slightly to provide clearance for the work. A slight improvement would be to turn a number of concentric rings on the face to facilitate adjustment of the nurls. For use in the lathe it is only necessary to hold the work in a pair of copper grips against a female back centet and feed into the nurls while rotating.

London, England. W. MADDISON.



ADJUSTABLE NURLING TOOL

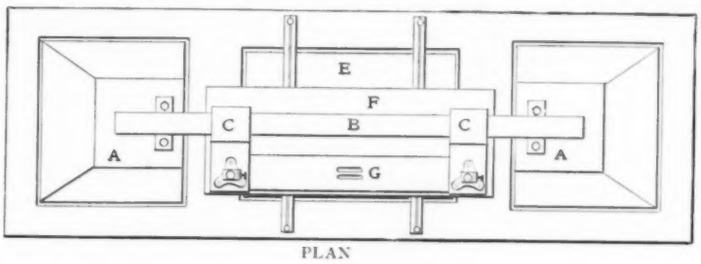
METHOD OF COMPARING STANDARD MEASURE BARS

A Simple Process for Deriving the Yard from the Meter Bar

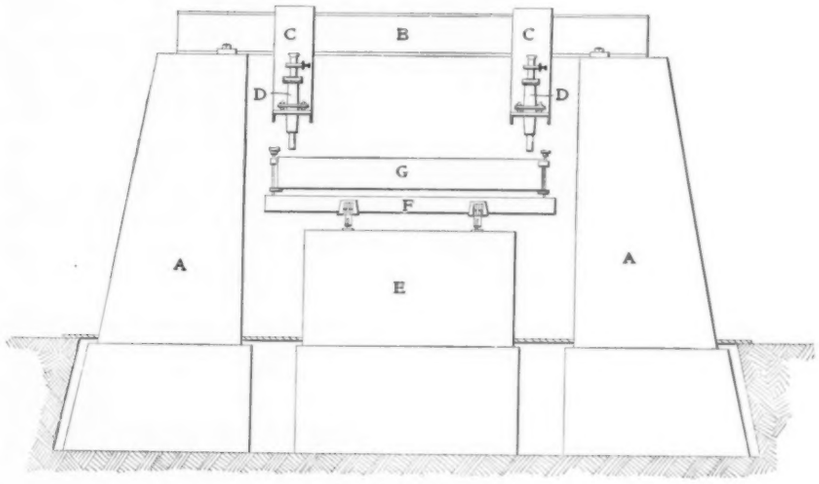
BY LOUIS A. FISHER*

It having been publicly stated that our present standard yard and inch measurements are derived from a standard meter bar, there have been strenuous objections to that procedure; some based upon what appear to be sentimental reasons, and others upon an asserted belief that the meter and the yard are incommensurable and that therefore the yard and the inch cannot be derived from the meter with accuracy.

The assertion that the yard cannot be derived from the meter reveals an entire lack of knowledge of the methods employed in doing such work. It is no more difficult to measure a distance of 914.4018 millimeters, the length of the United States yard, than it is to measure 39.3700 inches, which is the length of the meter.



PLAN



ELEVATION

FIG. 1. METER COMPARATOR, BUREAU OF STANDARDS

FIG. 2. METHOD OF COMPARING SUB-DIVISIONS

Accuracy, of course, does not mean the same to all persons. To the stone mason it means one thing, to the railroad machinist another, and to the gage maker quite another.

Most things manufactured are not an even number of millimeters or inches, and therefore a standard which cannot be subdivided or multiplied is not of much service. So much for any argument against the possibility of accurately determining the value of an intermediate graduation of any standard. If it is not admitted that this can be done, then how can the inch be derived from the yard?

There is not the slightest possible doubt but what the yard based upon the International meter can be reproduced with greater accuracy than it can be determined by comparison with the present British Imperial yard, which is made of an alloy of copper, tin, and zinc.

To the uninitiated this may seem strange, but the Imperial yard and its copies are so massive that it is extremely difficult to get their true temperature unless they are kept at a constant temperature for a number of hours, and even then the relatively coarse lines on these bars make it impossible to obtain the highest accuracy. In addition to these defects there is reason to doubt the permanence of the alloy composing the bars. On the other hand, the International meter and its copies are so designed as to readily take up the temperature of the thermometers in contact with them and the alloy of platinum and iridium composing these bars is the most permanent known to mankind. Very recently the British Government had a new platinum-iridium yard made and carefully compared with the present Imperial standard and it is my opinion that this bar will soon replace the older standard.

It should be a subject for congratulation to all Americans interested in metrology that those entrusted with the care of our standards should have been the first to appreciate the unreliability of the British yard as a permanent standard, and that they should have referred the American yard to an International standard which is at least partly under the control of the United States.

The copies of the International meter deposited at the Bureau of Standards at Washington have been carefully compared at the International Bureau of Weights and Measures near Paris and are far more reliable than any yard bar in the possession of the United States Government or of the Government of Great Britain. This is so simply because when the standard meter bars sent to the various participating nations were designed advantage was taken of the best expert knowledge of the world to so design the bars as to give them the greatest stability. In material, form, and fineness of lines they are superior to any bars previously made,—superior in that measurements made with them with equal care are sure to be more concordant than if made with any bars previously constructed. This has been proven by tests made by a number of careful experts and there is no room for differences of opinion concerning it. The fact was discovered long before the organization of the Bureau of Standards, when our standards of length were in the custody of the Coast Survey, and the present practice of the Bureau of deriving the yard from the meter is simply a continuation of the practice of its predecessor.

In compliance with the request of the editor, I submit the following description of the method employed in comparing a yard with a meter, which I have endeavored to make as free from technicali-

*Mr. Fischer is in special charge of the Division of Weights and Measures at the Bureau of Standards, Washington, and has made the comparisons he here describes. He has, so to speak, been raised with the standards, having been employed in the Coast Survey on such work before the Bureau of Standards was organized.—Ed.

ties as the subject will permit. In theory and in practice such a comparison is very simple, yet I hesitate to give it for fear it will appear more complicated to the uninitiated than it actually is.

The comparison of the yard with the meter is merely the comparison of the yard with a space equal to 914 millimeters of a standardized meter, the difference between the two being measured with a micrometer precisely as the difference between two yards or two meters is measured and with the same degree of accuracy. If, therefore, the yard is defined as a certain fraction of the meter, the operation of comparing it with a millimeter scale presents no unusual difficulties.

The apparatus required for such a comparison is, as follows:

1. An accurately known copy of the International meter, divided into millimeters, with the corrections to the graduations known;

2. A micrometer comparator capable of comparing lengths up to at least one meter;

3. The yard, the value of which is to be determined.

The standard temperature for the yard is 62° F., or 16.67° Centigrade.

The yard at 62° F. is equal to 0.9144018 meters, or 914.4018 millimeters of the standard meter at 0° Centigrade. If the coefficient of expansion of the meter is known, the value of the space 914 millimeters can, of course, be determined at 16.67° C. (62° F.) or at any other temperature. It is only necessary, therefore, to compare the space 914 millimeters with the yard at 62° F., or if the expansion of the yard is known the comparison could be made at the melting point of ice.

Or, if one wishes to eliminate entirely the question of expansion, the meter may be kept in a box filled with shaved ice and the yard in another box filled with water maintained at 62° F. The temperature of the bars under these circumstances may be easily controlled and accurately determined. The difference in length of the two bars can then be measured by means of the microscopes of the comparator, and if both are correct this difference will be 0.4018 millimeter.

The comparison is effected by bringing the two bars successively under two micrometer microscopes whose optical axes are rigidly fixed 36 inches apart. The microscopes may be fastened to a heavy metal beam which is protected from rapid thermal changes by asbestos, cork, or other heat-insulating material, or the microscope may be mounted on two independent piers connected only by the ground on which they rest.

The arrangement of a comparator of the first type is shown by Fig. 1. The essential features of the comparator are two stone piers *AA*, which support the ends of a heavy iron I-beam *B*, to which are clamped two heavy iron brackets *CC*. These brackets support the microscopes *DD*. The microscope supports may be clamped anywhere on the I-beam, and hence the comparator may be used for comparing bars having any length from 0.1 meter to 1 meter.

In addition to the I-beam and its two supporting piers, an intermediate pier *E* supports two steel rails upon which the carriage *F* moves transversely to the I-beam. Mounted upon this carriage is a box *G*, inside of which the bars to be compared are placed. The box rests upon three adjusting screws to focus the bars under the microscopes. Two such boxes are required if the comparison of the bars is to be made with the yard at 62 degrees F., and the meter at zero Centigrade.

While the determination of the subdivisions of bars is tedious, it is an everyday operation. The foot and the inch are both derived from the yard, and in precisely the same manner the decimeter and millimeter divisions of a meter may be determined from the meter. On account of the importance of this step in the work, it may be well to illustrate diagrammatically how the subdivisions of the bar are determined in terms of the total length of the bar.

If we wish to know the space 0 to 914 millimeters of a meter bar, we would first compare all the decimeters with one another by fixing two micrometer microscopes 0.1 meter apart and then by displacing the bar in the direction of its length under the microscopes we compare every 0.1 meter or decimeter of the bar with the space fixed by the microscope, as indicated by Fig. 2.

Let L be the distance between the centers of the microscope, and x_1, x_2, x_3—x_{10} be the variation of the decimeters of the meter from L, that is:

$$\begin{aligned}
&0. \text{ to } 0.1\ m. = L + x_1\\
&0.1 \text{ to } 0.2\ m. = L + x_2\\
&0.2 \text{ to } 0.3\ m. = L + x_3\\
&0.3 \text{ to } 0.4\ m. = L + x_4\\
&0.4 \text{ to } 0.5\ m. = L + x_5\\
&0.5 \text{ to } 0.6\ m. = L + x_6\\
&0.6 \text{ to } 0.7\ m. = L + x_7\\
&0.7 \text{ to } 0.8\ m. = L + x_8\\
&0.8 \text{ to } 0.9\ m. = L + x_9\\
&0\ 9 \text{ to } 1.0\ m. = L + x_{10}
\end{aligned}$$

Let $x_1 + x_2 + x_3 + x_4 + \ldots + x_{10} = X$,

then $0 \text{ to } 1.0\ m. = 10\,L + X$,

or $10\,L = 1\ m - X$.

Now since the x's were measured with the micrometer* they are known quantities. It therefore follows that

$$L = 0.1\ m. - \frac{X}{10}.$$

It is apparent that if L, the distance between the microscopes, is known, the value of every decimeter can immediately be determined by adding or subtracting the corresponding value of x, according as it is plus or minus; and if each decimeter is known, the space 0 to 0.9 meter will be known. In exactly the same way we can determine the values of the centimeters of the space 0.9 to 1.0 meter, and again the millimeters of the space 0.910 to 0.920 meter, which includes the 914th millimeter.

The above method is merely a skeleton to illustrate in a general way the process of calibration. In work of the highest precision the above shows only the first step. After the decimeters are compared with one another the microscopes are next placed two decimeters apart and the two decimeter spaces of the meter are compared; thus 0 to 2 dm., 1 to 3 dm., 2 to 4 dm., 3 to 5 dm., 4 to 6 dm., 5 to 7 dm., 6 to 8 dm., 7 to 9 dm., and 8 to 10 dm. Then the 3, 4, 5, 6, 7, 8, and 9 dm. spaces are compared with the microscopes placed at the proper distances; the last distance between the microscopes being 0.9 meter which is compared with 0 to 9 dm. and 0.1 to 1 meter of the standard meter. What is termed a "least square adjustment" is then made of all these observations. It is possible by this process to determine any space on the meter with an error not greater that 1/10,000 mm. (the 1/254,000 inch), which is practically the limit of microscopic comparison, and is believed to be "accurate" within any reasonable, or practicable, understanding of that term. Absolute perfection is not, of course, attainable in work of this nature, whether we are comparing metric and inch measurements or comparing inch with inch. We do not expect to find graduations exactly where they should be, but aim to determine the amount of their error, and by the method described it is as easy to do this when comparing a yard bar with a meter bar as it is when we compare two meter bars or two yard bars.

*The value of the micrometer screw is determined by comparison with a known millimeter.

Foundry and Machine-Shop Products of the U. S.

The United States Bureau of the Census has compiled the returns of 1905 covering the manufacture of foundry and machine-shop products in the United States, and in the ten leading States, in the order of their output. From these figures it appears that in 1905 there were 8993 establishments with a capital of $845,024,825, as compared with 9324 establishments having a capital of $665,058,205 in 1900. The item of capital includes live assets only, and bears no relation to issues of stocks and bonds. There were 348,381 wage earners, receiving $196,247,413 in wages in 1905, against 350,327 receiving $182,232,009 in 1900. The miscellaneous expenses of the industry in 1905 were $70,094,411, as compared with $41,103,995 in 1900. The materials consumed in 1905 were valued at $278,074,203, against $286,357,107 in 1900, while the total value of the product of the industry in 1905 was $685,901,388, compared with $644,990,999.

Pennsylvania returned the largest total product in 1905, amounting to $112,856,748, a loss of nearly $15,000,000 as compared with 1900, when the total was $127,292,440. In 1905 the establishments numbered 1182, as compared with 1260 in 1900, and the capital was returned at $169,646,734, as compared with $154,958,750. There was a decline in the number of wage earners from 62,828 to 56,853, and in wages paid from $33,199,521 to $31,231,113. The items of miscellaneous expenses increased from $6,830,037 to $10,995,027, but the cost of materials declined from $62,336,770 to $48,149,886. New York still holds second place, but the product shows a decline from $96,636,517 to $91,432,923. Ohio, which reported a product valued at $72,399,632 in 1900, has made a large gain. Massachusetts also showed a decline. All the Western States showed gains.

The Jamestown Exposition — Plenty of Room Provided for Display of Machinery and Manufactures

The Jamestown Exposition, celebrating the ter-centennial of the first permanent settlement of English-speaking people in America, will open April 26 and close November 30, 1907. The place chosen on Hampton roads, one mile north of the city of Norfolk, Va., and directly across the roads from Fortress Monroe and Newport News, is in one of the most historical sections of America. While the first settlement was at Jamestown island about 30 miles up the James river, it was decided on account of better transportation facilities to hold the exposition at the point mentioned.

The selection of this place also makes possible an international naval, marine and military celebration, which will form a striking feature of the exposition.

The Manufactures and Liberal Arts Building and the Machinery and Transportation Building will be two of the largest structures on the grounds. Other buildings will be devoted to art, army and navy appliances, foods and accessories, mines and metallurgy, marine appliances, etc. The concession division, known at various recent expositions as the Midway, the Pike, and the Trail, will here be called the War Path.

The Machinery and Transportation Building is to be 535 feet long, and 280 feet wide, the total area being 131,000 square feet. The plan shows four longitudinal and seven cross aisles dividing the floor into 28 sections. The charge for space in this building has been fixed at $1 to $1.50 per square foot, the higher figure being for space fronting on two aisles. The officials desire that applications for space for machinery and appliances intended for exhibition in operation shall be filed not later than November 1, 1906; and in the case of machinery not intended for operation, not later than December 1. The principal offices of the Exposition are at Norfolk, Va., and any information desired relative to exhibits in the Machinery Building may be obtained from Capt. J. E. Reinburg, of the Department of Machinery.

The Metric System in England

What seems to have been deemed of sufficient importance to be made the subject of a special cable despatch to *The Sun*, of New York, reads as follows:

"Kynochs, Limited, the well known Birmingham manufacturers of ammunition and explosives, announce that they are tired of awaiting legislation establishing the metric system in Great Britain and that they have decided to be the first great British firm to adopt that system.

"Arthur Chamberlain, brother of Joseph Chamberlain, who is managing director of Kynochs, says that the change will be surprisingly simple, involving only the alteration of the scales on the arms of weighing machines and the simplification of account books. Instead of eight or nine columns for weights and three for money there will be wanted only two columns, one for weights and one for values. Wages will be calculated in decimals and translated afterward into pounds, shillings and pence.

"Officials of the Decimal Association say that British manufacturers are losing millions annually in their dealings with countries using the metric system by not adopting it. A renewed attempt will be made at the coming session of Parliament to pass a bill for the compulsory adoption of the system."

The concern referred to is one of the most important in Great Britain. We are not as yet clear as to just what has been done, or what is proposed to be done by them with regard to the metric system. The cablegram is somewhat hazy and bears evidence of having passed through the hands of men not very familiar with the subject of which they were writing.

Our Antiquated Methods of Spelling, Weighing and Measuring

Mechanics generally are not very strong on spelling. They are too busy to learn it; spelling of English is very hard for many and other things seem more important. Readers will be interested and somewhat amused by an article by Dr. T. J. MacNamara, M. P., in the *London Mail*, in which he presents in an interesting way some of the anomalies of our present spelling, and curiously enough classes it with our system of weights and measures. His belief as to a cause of the alleged stolidity of English character is also novel and interesting. We quote as follows:

He is taught that "i" comes before "e" except after "c," and is straightway taken to task for spelling "seize" "s-i-e-z-e," or "heir" "h-i-e-r," or "feign" "f-i-e-g-n," and so on. He is solemnly adjured to drop the final "e" when adding "ing" to a verb, and then comes a rebuff for spelling "shoeing" "s-h-o-i-n-g." They teach him that while "fulfil" has only one final "l" that final "l" is doubled in "fulfilled." And when he goes on to apply the rule to "fulfillment" there is trouble. Then they teach that "r-o-u-g-h" spells "ruff." In simple faith he spells "stuff" "s-t-o-u-g-h." They drum into his head that "l-a-u-g-h" is "laff," and privately vote him a thick head when he spells "staff" "s-t-a-u-g-h."

I believe the stolidity of the English character and its implicit acceptance of authority is due in a large measure to the fact that long before it leaves the spelling class it is ready to believe anything. And this unquestioning attitude of mind is only rendered the more hopeless when it comes to learn that in one case twelve ounces make a pound, in another case it requires sixteen. Indeed, if we had set ourselves deliberately to stamp out rational instincts and the habit of logical and thoughtful inquiry in the child mind, we probably could not have devised two more fiendish instruments than our scheme of spelling on the one hand and of weights and measures on the other.

Spiral Gears—I—Erratum

Fig. 7, page 464, for ϕ read θ.

The discussion of the subject of water finding by a twig in the hands of what are called in England "dowsers" continues unabated and now Professor Wertheimer, principal of the Merchant Venturers' Technical College, at Bristol, has conducted a test of the matter; his conclusion being that the dowsers make no better guesses at the presence or location of water than do others who make no special claim in that direction, and use no twigs or other devices. It would seem from his experiments that streams of water underground are plentiful, so plentiful that a large percentage of guesses turn out to be more or less accurate. He does not, however, accuse the dowsers of dishonesty, but believes that many of them are sincere, and that they believe they can detect the presence of water. The professor believes they are self-deceived.

The motor touring car is being succeeded by the motor dining car, which is the conception of a Pisa (Italy) restaurateur. The latter has had built three cars with very large body, divided into two compartments, one serving as kitchen and the other as dining room. The customers of this up to date restaurateur take their seats in the car, which starts at a fixed hour for a trip through the most picturesque surroundings of the city.

AMERICAN MACHINIST

Issued Weekly by the

Hill Publishing Company

505 Pearl Street, New York.

Also Published at 6 Bouverie Street, London, E. C.

Correspondence on mechanical subjects solicited and paid for. Name and address must always be given—not necessarily for publication.

Address all business communications to the American Machinist, 505 Pearl Street, New York. Matter for reading columns may be addressed to the Editor.

Subscribers can have address changed at will. Give old and new addresses. Date on wrapper denotes end of month in which subscription expires.

Subscription price $4 per year, postage prepaid, to any post office in North America; $5 in all foreign countries except Europe and British possessions in Eastern Hemisphere.

The AMERICAN MACHINIST CO., LTD., 6 Bouverie St., London, E. C., will serve all subscriptions for Europe and British possessions in Eastern Hemisphere. Price 30 Shillings for England. For all other countries in Eastern Hemisphere, 35 Shillings.

No back numbers beyond current year. For sale by all newsdealers generally.

Entered at New York Post Office as mail matter of the second class.

Cable Address, "MACHINIST," N. Y.
Lieber's and A. B. C. Codes.

During 1905 *the* AMERICAN MACHINIST *printed and circulated* 1,059,100 *copies, an average of* 20,367 *per issue. Of this issue* 17,750 *copies are printed. None sent regularly free. None taken back from newsstands. No back numbers beyond current year.*

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Correspondence Instruction—The Anniversary of the Birth of an Idea

In Scranton, Penn., on the 16th of October, there was a gathering of men from all parts of the United States to celebrate the 15th anniversary of the entrance into the educational field of a new idea—an idea which has been proven, during the intervening time, to have in it the living germ which has enabled it to grow to undreamed-of proportions and influence, and which may enable it to grow to far greater proportions.

Fifteen years ago the International Correspondence Schools were founded by T. J. Foster, who is still at the head of them. Their growth during the period referred to has been at a rate far surpassing what anyone would have supposed to be possible. Today the correspondence system of teaching is an educational engine of tremendous power and influence, and the modest, unassuming man at the head of these schools is doing a work the importance of which he, nor anyone, can measure.

On the day referred to, during exercises held in Scranton's largest theater, before an audience of educators, engineers and business men from all parts of the country, the mayor of Scranton, the governor of Pennsylvania, and other men of high standing and renown, testified to their high appreciation of these schools and their work, and Mr. Foster himself read a paper, which we shall publish next week, and in which he gave not merely an account of the growth of the schools, and of their present magnitude, but laid bare, with the utmost frankness, the underlying ideas upon which their success has been founded, revealing the fact that, notwithstanding the present success from a pecuniary standpoint, there is in the work much more than a mere consideration of dollars and cents—a heart and soul inspired by the consciousness of a far-reaching service to mankind—a service which, previous to the launching of this new idea, had not been rendered at all, and which no one knew how to render.

In the evening, at a banquet given by the schools in Scranton's armory to about 600 invited guests, eminent speakers, including William Kent, Elbert Hubbard, Nathan C. Schaeffer (State superintendent of public instruction) John Mitchell and Judge H. M. Edwards, joined in expressing, each from his standpoint, his high appreciation of the work being done, and of its influence upon our citizenship and our economic progress.

In Mr. Foster's address, to appear in our columns next week, there are many things of great interest. From it one may discern what it is that has brought such tremendous success to the correspondence schools, and the reason for a true and a great success is always worth knowing.

Correspondence instruction, faithfully carried on, has mostly passed the period of distrust which pertains to all new ideas. Recently the University of Wisconsin has announced the establishment of a correspondence instruction department for the purpose of enabling those residents of the State who are unable to go to Madison and study to yet derive some benefit from the great university which they support. To paraphrase a familiar saying, the present state of correspondence instruction illustrates the fact that, when confronted with a brand new idea we first ridicule, then examine it, then declare that we have known from the beginning that it was a good thing, and bound to succeed.

Licensees Under Patents vs. Combined Manufacturers

The real reason for the maintenance of the main patent on automobiles and of the Association of Licensed Automobile Manufacturers is gradually coming to be well understood. The Selden patents and others owned by members of the association serve simply to enable the manufacturers to belong to a combination and to do things which would be contrary to law if they did them as associated manufacturers instead of as licensed manufacturers doing business under a patent right.

As is well known to our readers the patent laws give a patentee, or the owner of a patent, the exclusive right to manufacture and sell the patented article within the territory of the United States for a term of 17 years. This includes the right to prescribe the terms upon which the article shall be sold, its price, the number to be sold by each licensee, etc. Agents may be appointed by the patentee, which agents must do business upon the terms prescribed by him. It is thus readily seen that the Association of Licensed Automobile Manufacturers can enjoy under the protection of this patent many privileges which the courts would deprive them of very quickly, if it were not for the patents, and that they can do many things which would be unlawful if it were provable that they were associated together simply for the purpose of controlling prices or regulating trade in any way.

Automobile manufacturers are not the only ones who have taken advantage of this feature of the patent laws, and it is probable that other organizations and manufacturers will take advantage of it, perhaps to the extent of bringing about a public sentiment, which will cause some modification of the patent laws designed to meet this new condition.

We understand that some lawyers are advising their clients that it is unsafe, under the present laws, for a manufacturer to belong to such an association as the National Association of Machine Tool Builders. Just why it should be unlawful we are unable to perceive, as we do not

understand that the association has ever attempted to prescribe or fix prices. Its members have at times agreed to a certain percentage of advance of prices, but there never has been any attempt to bring about uniformity of prices; nor in the nature of the case could there be any such attempt. For this and other reasons we do not see why such an association is or ought to be unlawful. Nevertheless, there is said to be good legal opinion to the effect that it is; and, if so, then it would seem a very simple matter to organize upon the basis of the ownership and control of certain patents which apply to machine-tool construction, many of which are at present owned by members of the association referred to. We shall not be surprised if such a change in the form of the organization takes place if any real trouble is threatened as a result of membership in it.

Hindoo Coal Miners' Wages and the Profits of Mining

A recent number of the *Daily Consular and Trade Reports* in its department entitled "Notes and Comments," which seems to consist of short editorial paragraphs, has the following:

"The wages paid in India for mining coal, 22 cents a ton, ought to make that a profitable undertaking to the operators. Women are employed as laborers about the mines. Both the wages paid the men and the employment of women are discreditable."

Perhaps we do not quite understand the situation with respect to these consular reports. It is, however, a Government publication, and, to say the least of it, it would seem to us as though comments of this kind in a publication issued by the authority of a great government are rather undignified, and out of place. In the first place, there is no proof, and it does not by any means follow that because only 22 cents a ton is paid for mining coal in India, that therefore the business of coal mining is profitable there. Whether it is extraordinarily profitable, or in fact profitable at all or not, depends upon a good many things besides the wages paid: and if the government of India chose to issue a publication it could find cases of wages paid in this country, and of the employment of women and children which it would be equally justified in saying were discreditable. At any rate, the editor of the *Daily Consular Reports* ought to know that the highest wages are paid in some of the most profitable lines of business, and the lowest in some of the least profitable.

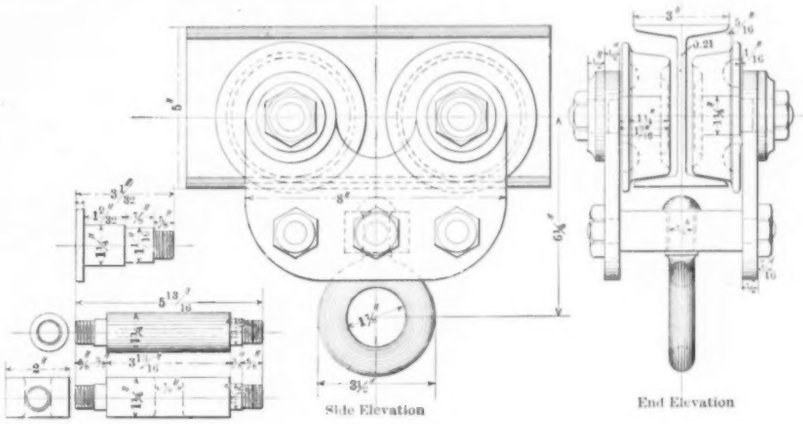
The coefficient of linear expansion of concrete of the proportions 1:2:4 has been determined as 0.0000055 for 1 degree Fahrenheit, while for steel it is 0.0000066, and for wrought iron 0.0000068.

NEW TOOLS AND MACHINE SHOP APPLIANCES

AN I-BEAM TROLLEY

The illustration shows a trolley designed to run on the lower flange of an I-beam and to carry with it a chain hoist or other means for handling heavy loads.

The sides are of steel plate, bound together by bolts. The wheels of the various sizes run on steel studs, having extra supports on the outsides of the side plates. They are made as large as the I-beam, upon which they are to run, will permit, so as to give large wearing surface and a minimum amount of friction.



AN I-BEAM TROLLEY

These trolleys are made by The Franklin Moore Company, Winsted, Conn.

A COLLAPSIBLE TAP

Fig. 1 shows a collapsible tap. The body of the tap is made of a single piece of steel. The center plunger backs up the chasers in such a way as to make the tap almost as rigid as a solid tap. It is very sensitive, and will collapse or trip with a very slight pressure, and in such a way that it is impossible for the chasers to stick, thus damaging the thread. It is so constructed as to be fully automatic when used on an automatic machine, turret lathe or drill press. The lever is made solid when the tap is to be full automatic. When made to be semi-automatic, the lever can be hinged so that it will lie close to the body of the tap, thus allowing the tap to be used very close to any projection or obstruction. The body of the tap is as small in small taps and smaller in large taps than the diameter of the chasers, so that the operator can always see his work. The tap is made with chasers for pipe, standard or special threads. It is also made with reamer cutters. Every tap is so constructed that it will cut pipe thread and three sizes of standard thread, thus virtually making four taps in one by merely having four sets of chasers. The tap is also made with reamer attachment, thus being able to ream and tap a hole at the same time.

A NUT-FACING MACHINE

Fig. 2 shows the nut-facing machine. The machine has two spindles, a large, hollow spindle which holds the chuck or screw plate; the smaller spindle works in the hollow spindle, and projects through this spindle, automatically taking on the nut. In relieving the nut, a friction clutch holds the small spindle, while the large hollow spindle revolves, thus unscrewing and dropping the finished nut into the box.

FIG. 1. THE COLLAPSIBLE TAP

The machine is driven with a four-step cone pulley, 4-inch face. Size of front bearing 3 inches diameter, 5½ inches long. Back bearing 2 inches diameter, 4½ inches long.

Mandrels are furnished with straight or taper threads. Straight-thread mandrels have an equalizing collar. The sliding head that holds the facing tool has a cross slide operated by screw. The sliding head has a 2-inch hole to admit a facing tool. Any kind of box tool can be used in the sliding head for facing or turning work. The

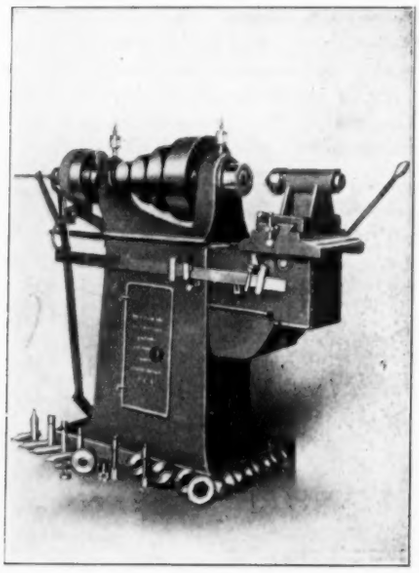


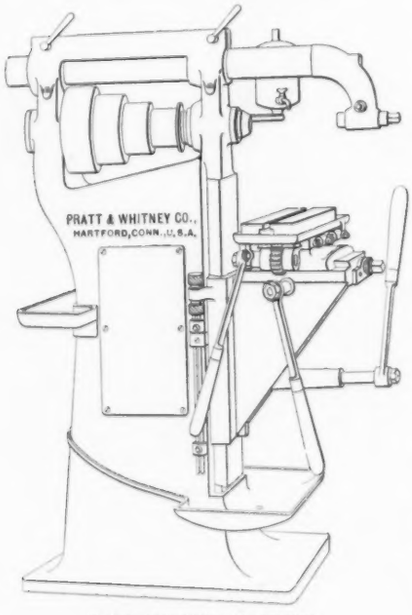
FIG. 2. A NUT-FACING MACHINE

driving head can be removed, and lathe chuck or any other kind of chuck can be put on to face and bore collars or any other work of like character or design. The machine can be furnished with turret head to hold four tools for facing and turning work.

These two tools are made by the G. M. Yost Company, Waynesboro, Penn.

HAND MILLING MACHINE

In this machine the head is cast solid with the column and the cone is reversed to give extra strength at the front bearing. The bronze bearings are taper and split, thus providing means of compensating for wear. The knee has a long bearing surface on the column and may be raised and lowered through a distance of 8 inches by means of a hand lever. It is counterbalanced by a weight inside the column. For the cross feed of the table, which has a movement of 5 inches outward from the column, a screw is regularly furnished; but a combination screw and rack feed can, if desired, be substituted. The change from screw to rack feed is readily accomplished by removing the screw bearing from the outer end of the knee together with the screw, and then clamping the hand lever for operating the rack feed, in any desired position. The longitudinal feed of the table is by a lever, the maximum movement being 7½ inches. Adjustable stops in both directions are provided for the three slide movements. A swinging oil pot with spout is located on the head and an oil pan is cast solid with the column, thus insuring cleanliness in operation. The machine can be furnished with or without overhanging arm. With the overhanging-arm machine, a vertical milling attachment can be provided, this attachment being clamped rigidly to the cylindrical portion of the arm, which for this purpose is reversed end for end in the machine. The spindle of the attachment is driven by gearing from the main spindle of the machine, and can be set to run at any angle in a vertical plane parallel to the main spindle. The tapered holes in both spindles are made alike, thus providing for interchangeability of cutters. The front bearing of the main spindle is 1⅝ inches diameter x 4⅞ inches long. The driving cone takes a 2½-inch belt and its largest step is 8 inches diameter. The table measures 4¾x16 inches. The greatest distance from the table top to the spindle center is 9 inches. The dimensions of the countershaft pulleys are 10x3 inches, and the speed of the countershaft is 175 turns per minute. The miller is built by the Pratt & Whitney Company, Hartford, Conn.



HAND MILLING MACHINE

Changes in Faculty and Equipment at Purdue University

Purdue University, on September 12, entered upon its thirty-third year. At the end of the second week, 1588 students had been enrolled. Out of this number, 1379, or 86 per cent., were registered in the schools of engineering.

New appointments to the instructional staff of the engineering department for the present year have been announced as follows: W. K. Hatt, Ph. D., formerly professor of applied mechanics, to be professor of civil engineering in charge of the department; Paul N. Breneman B. S. 1894, C. E. 1897, State College of Pennsylvania, formerly engineer and superintendent mining construction and operation, to be instructor in civil engineering; Arthur W. Cole, B. S., Worcester Polytechnic Institute, 1902, formerly of the University of Maine, to be instructor in thermodynamics; L. W. Wallace, B. S., Texas A. & M. College, 1903, late with the motive-power department of the Santa Fé Railroad, to be instructor in car and locomotive design; W. T. Small, B. S., Purdue, 1903, formerly with the Cooper-Hewitt Electric Company, to be instructor in the electrical laboratory; C. E. Schutt, B. S., Purdue, 1905, formerly with the New York Telephone Company, George W. Lamke, B. S., University of Michigan, 1906, and W. A. Rush, B. S., Purdue, 1906, to be assistants in the electrical laboratory; R. D. Kneale, B. S., Purdue, 1906, and M. L. Allen, B. S., University of Wisconsin, 1906, to be assistants in the civil-engineering department.

The facilities of the engineering department have been increased by the completion of a building containing three floors, each 75x130 feet, for the department of civil engineering, and by an addition to the electrical laboratory 68x90 feet to give room for additional equipment. This room is to be served by a traveling crane which may be utilized in transferring heavy equipment from the laboratory to a new lecture room which adjoins. There have been added to the material-testing laboratory and to the steam-engine laboratory a number of important machines, including a 100,000-pound Olsen testing machine, a Fairbanks-Morse 50 horse-power gas producer and gas engine, a 20 horse-power DeLaval steam turbine with direct-connected centrifugal pump, a 16 and 10x14 air, and 11 and 18x14 steam Ingersoll-Rand air compressor, a Foster superheater of the type supplied by the Power Specialty Company, a Gerry-Emmons gasolene engine, an Abner Doble water motor, and an Allis-Chalmers 8x24-in. Corliss engine direct-connected with a centrifugal pump of 4000 gallons capacity.

With a larger instructional staff, and with a considerable amount of new equipment, it is expected that the larger classes of the present year will be handled as efficiently as the smaller classes of previous years.

We would like information as to the present whereabouts of the Copeland Manufacturing Company, builders of hoisting machinery, or their successors.

A Swiss inventor, Adolph Schmid, has constructed an instrument which, mounted on a tripod placed on the ground, will, he claims, indicate the presence of subterranean water. Has it come to this, that our old friend the hazel twig must be modernized, and the dowser replaced by an automatic instrument looking like a voltmeter or something of the kind?

Dedication of the Engineering Laboratory of the University of Pennsylvania

Elsewhere in this issue we begin an illustrated description of the most costly and magnificent engineering laboratory possessed by any educational establishment in the English-speaking world.

The dedicatory exercises were held in one of the larger rooms of the laboratory the afternoon of October 19 and were attended by many distinguished representatives of other educational institutions and by the representatives of the United States, the German, the French and the Mexican Governments. Provost Harrison in accepting from the architects of the building the key to its rooms paid a special tribute of praise to Professors Spangler and Marburg, respectively of the mechanical and the civil-engineering departments, in recognition of their work in connection with its design and equipment.

The degree of Doctor of Science was then, with impressive ceremony, conferred upon Henry W. Spangler, Frederick P. Stearns, Edgar Marburg, Fred W. Taylor, Mansfield Merriman, Samuel Sheldon, Samuel M. Vauclain, Charles W. Rae, Henri Vertillart, Alexander Mackensie, Ramon Ibarrola, John Fritz and William P. Blake.

The principal addresses were delivered by Fred W. Taylor, of Philadelphia, and Alexander C. Humphreys, president of Stevens Institute. The former, while not underrating technical schools, nor their graduates, yet expressed the opinion that too much freedom to do as he pleases and too much indulgence in careless work is allowed the average student. The speaker called attention to the fact that instead of 60 failures to perform his full duty being allowed a worker in the commercial and industrial world about three are usually sufficient to insure dismissal. The speaker declared that he himself had learned things of more value to him while working in a shop and alongside of men who were working earnestly to support themselves and their families than he had ever learned elsewhere. He believed that there should be less of elective courses, less of trying to make things easy for students and more of such discipline as men are bound to get sooner or later before they can become valuable to any employer. Instead then of graduates being, as they so often are now, practically worthless, unless at least two years of practice are gained they might become valuable immediately upon graduation.

Mr. Taylor's address, the title of which was "A Comparison of University and Industrial Discipline and Methods," was very well received and stimulated much subsequent discussion among those who heard it.

Mr. Humphreys spoke on "The Engineer as a Citizen," and his address was devoted largely to a subject now very prominent in New York and vicinity especially, i.e., "yellow journalism" and its works. He spoke for conservative procedure, for criticism of corporations and business enterprises by those only who possess full or perhaps expert knowledge of the subjects criticized, and expressed the conviction that the graduates of our colleges and universities ought to consider themselves especially depended upon to direct, guide and educate public opinion to the end that there may be greater and clearer discrimination between the right and the wrong of these matters.

In the evening, at the Union League Club, there was a banquet attended by about 200 graduates and their guests, at which there was much of college enthusiasm and mutual congratulationss upon the successful completion of a great work. Arthur L. Church acted as toastmaster and among the speakers were Professor Spangler, Professor Marburg, Prof. Wm. F. M. Goss of Purdue University, Admiral Melville, James M. Dodge and Charles Whiting Baker, editor of *Engineering News*, who spoke of "The Technical Press."

Mr. Dodge spoke of "The Engineering Profession," referring particularly to a change which has taken place, so that whereas, formerly, business men who became stuck in the progress of their schemes consulted engineers for help, it is now the engineers who evolve and work out the schemes, and then go to the business man for the wherewithal to carry them out.

Admiral Melville spoke particularly of the navy, the service it has rendered, and is ever ready to render, and the importance of keeping it up to a high standard of efficiency. He also referred to the very great change that has taken place in the character and equipment of naval vessels, and said that naval operations are now essentially engineering, and that every naval officer must be a good deal of an engineer, no matter what he may be besides.

Personal.

Will our correspondent, W. Parker, kindly send his full address to the editor?

Paul E. Noé has succeeded J. W. Copeland as Chicago representative of the Braeburn Steel Company. Mr. Copeland will engage in the railway supply business at Minneapolis.

C. R. McGahey, for the past two years superintendent of the Lombard Iron Works, Atlanta, Ga., has resigned and accepted the position of general superintendent of the E. Van Winkle Gin and Machine Works, of the same place.

Wm. J. Kennedy, for many years boiler inspector for the International Navigation Company, has started business at 195 Greenwich street, Manhattan. He will make a specialty of scaling, cleaning, repairing and preparing boilers for inspection.

Obituary

Arthur R. Jones, superintendent of the American & British Manufacturing Company, of Bridgeport, Conn., died suddenly at his home October 11, 35 years old.

Sir Richard Tangye, head of the engineering firm of Tangyes Ltd., Birmingham, England, died recently at the age of 73. He was the author of several books and with his brother George Tangye founded the Birmingham Art Gallery and Municipal School of Art.

New Publications

"Jahrbuch für das Eisenhüttenwesen." (Supplement to *Stahl und Eisen.*) A report on the progress of all departments of the iron industry in the year 1903. Prepared on behalf of the Verein deutscher Eisenhüttenleute, by Otto Vogel. Fourth year. 464 6x9½-inch pages, with 67 illustrations. Kommisionsverlag von A. Bagel, Düsseldorf, Germany. Price, 10 marks.

The present year's volume of this valuable German index and digest embraces literature—chiefly or entirely periodical—of the iron and associated industries for 1903. Its scope is somewhat increased as compared with previous volumes, the number of citations amounting to 2600. Some 141 periodicals are drawn upon, and of these 40 are in English, although the titles of articles and the occasional abstracts are printed in German. While the majority of articles are given by title simply, the abstracts suffice to fill a considerable portion of the book with textual and illustrative matter containing definite information. The subjects involved in the citations may be summarized, though inadequately, as follows: History and statistics; fuels, such as coal, coke, peat, petroleum and gas; firing of boilers, etc.; refractory materials; slags; ores; mill equipment; pig-iron production; foundry practice; wrought-iron and steel manufacture and finishing; properties of irons; iron alloys; testing, etc. Classified lists of patents are also given. Economics, labor and machinery come in for increased attention this year. An interesting feature is a parallel English-German-French vocabulary of metallographical terms. Copious author and subject indexes are appended.

Business Items

The Jeffrey Manufacturing Company, Columbus, Ohio, has established a new Canadian branch office in Montreal, Canada, at Lagauchetiere and Cotè streets.

The Dayton Pneumatic Tool Company, Dayton, Ohio, has doubled its capacity within the last six months. At a recent meeting of the stockholders of this company, Wm. W. Price was elected president and treasurer, David O.

Holbrook, vice-president, and F. W. Buchanan, secretary and general manager.

Butterfield & Co., Derby Line, Vermont, and Rock Island, P. Q., Canada, manufacturers of taps and dies, tap wrenches, screw plates, etc., have added a line of reamers to their product and are now prepared to furnish all types of reamers, such as hand reamers, locomotive reamers, bridge reamers, taper pin reamers, shell reamers, fluted chucking reamers, taper reamers for drill sockets, etc.

Peter A. Frasse & Co., Fulton street, New York, have purchased the patents, jigs, fixtures, patterns and machinery of the National Vise and Tool Company, of Woodston, N. J., formerly makers of the Stevens vises, Snediker rapid transit and quick-acting vises. This company has rented a new warehouse at 140-142 Worth street, New York, and installed a steel tube and steel department.

The Wade Machine Company, 133 Oliver street, Boston, Mass., has been incorporated under the laws of Massachusetts for the purpose of building special machinery, doing contract machine work of all kinds, making tools, dies, jigs and fixtures, and have equipped a large up-to-date shop at the above address. The officers of the company are W. H. Wade, president and treasurer, and A. S. Mello, secretary.

Manufacturers

The Wood Milling Company, Clyde, N. Y., will erect a new factory.

The Capital City Plating Works, Albany, N. Y., will erect a new factory.

The Hecla Portland Cement Company will double its plant at Bay City, Mich.

An addition will be built to the machine shop of S. L. Allen & Co., Philadelphia, Pa.

The Ajax Metal Company, Philadelphia, Penn., will erect an addition to its foundry.

F. P. Pfleghar & Son, New Haven, Conn., machinists, are putting up a new factory.

The Scudder Forging Company, St. Johnsville, N. Y., will erect a modern factory building.

The Northwestern Shot and Lead Works, St. Paul, Minn., will erect a new $12,000 factory.

The Consolidated Ice Company, Pittsburg, Pa., will erect a $150,000 plant in Lawrenceville.

Kitselman Bros., Muncie, Ind., manufacturers of wire fences, are enlarging their plant.

The Pfister-Vogel Leather Company, Cheboygan, Mich., will double the capacity of its plant.

The Morse Chain Company, Ithaca, N. Y., has commenced the erection of two additional buildings.

D. Allen, Los Angeles, Cal., has secured a permit to establish a brass foundry at 3115 Maple avenue.

The Electric Railway Equipment Company, of Cincinnati, O., will erect a branch plant in Wheeling, W. Va.

The Pleasanton (Kas.) Foundry and Machine Company has been organized. T. J. Blakey, president.

F. A. Heinze, of Butte, Mont., is back of a deal for the erection of a large electric-power plant near Missoula.

The Johnson & Sharp Manufacturing Company, hardware specialties, Ottumwa, Iowa, will erect a new factory.

The Excelsior Gas and Electric Fixture Company, Yonkers, N. Y., is planning to construct a new factory building.

The Horton Basket Machine Company, Elmira, N. Y., will enlarge its factory. A new foundry will probably be built.

The R. K. Le Blond Machine Tool Company, Cincinnati, O., will erect a storage and pattern factory to cost $15,000.

The George H. Pounder Company, Fort Atkinson, Wis., manufacturing farm machinery, etc., is building a large addition.

The De Luxe Motor Car Company, Toledo, Ohio, will move to Detroit, Mich., where eventually a $500,000 plant will be erected.

The Grand Rapids (Mich.) Refrigerator Company has selected a site for its new plant, on which about $100,000 will be expended.

It has been definitely decided to rebuild the Florence and Cripple Creek railroad shops at Canon City, Colo., which were recently destroyed by fire.

The American Safety Railway Switch Company has been incorporated at Salt Lake City, Utah, with a capital of $200,000. Joseph G. Jacobs, president.

The Harlan & Hollingsworth Corporation, Wilmington, Del., has secured a permit for the construction of a new building to be used as a pipe-fitters' shop.

The Young-Cole Lumber Company has been formed and will erect a sawmill in Eatonville, Wash. W. B. Cole, of Centralia, Wash., is manager and secretary.

The Henry H. Sheip Manufacturing Company, Philadelphia, Penn., lumber and cigar boxes, is having plans prepared for a new factory, to cost about $75,000.

A dry kiln at the plant of the Reliance Lumber Company, Tacoma, Wash., was destroyed by fire, causing a loss of about $14,000. It will be rebuilt at once.

The Hinde & Dauch Paper Company, Sandusky, Ohio, would like catalogs of clutch pulleys and power-transmitting machinery. These are to be addressed to desk No. 3.

The Lane-White Lumber Company's plant at Fort Smith, Ark., was destroyed by fire. Loss about $140,000. The company, which largely manufactured handles, will rebuild.

The Hamilton (Ohio) Manufacturing Company has been incorporated with a capital of $10,000. A factory will be erected for the manufacture of wood and metal specalties.

The Mexican Light and Power Company, Mexico City, intends to install a machine shop and foundry at its Necaxa plant, and would like catalogs for the complete equipment of such a shop.

The Allentown & Reading Traction Company, which has two power plants, one near Allentown and the other at Kutztown, will enlarge the latter plant and abolish the former.

The Pamlico Iron Works, Washington, N. C., has been incorporated with a capital of $20,000. A new brick building will be added to the present plant and fitted up with the latest machinery.

The Detroit (Mich.) Insulated Wire Company, a new concern, is erecting a plant. Temporary office is in the City and Suburban Homes Company's branch office at Michigan and Junction avenues.

The Memphis (Tenn.) Cold Storage Company has been organized and will erect an eleven-story building, installing a modern refrigerating plant. J. N. Oliver, B. H. Ashner and others, organizers.

The Consumers' Ice and Cold Storage Company, of Elizabeth, N. J., has been incorporated, with offices at 205 Broad street. Wm. H. Reynolds, P. J. Ryan and others, incorporators. Capital, $100,000.

The Washington (D. C.) Cold Storage and Ice Company, recently incorporated, proposes to erect a plant at a cost of $325,000. The capital stock of the company is placed at $500,000. W. V. Cox is president.

The Western Glass Company, Seattle, Wash., has filed articles of incorporation. The capital stock is $100,000 and Edward F. Sweeney is president. A plant for the manufacture of bottles, glassware and window panes will be erected.

The Eastern Tablet Company is having a plant erected in Albany, N. Y., which will be comprised of a factory and power house. The new factory will take the place of the two now maintained at Watertown and Brooklyn, N. Y.

The Pacific Hardware and Steel Company, a new concern, is erecting a rolling mill in South San Francisco, Cal., which it is said will probably be one of the largest steel plants in the west. Henry T. Scott is president of the company.

Catalogs

Humboldt Rope Meter Co., Humboldt, Tenn. Circular illustrating and describing rope meter.

Gem Manufacturing Co., Pittsburg, Pa. Circulars illustrating and describing Gem flexible shafting, steel oiler, flue scraper, etc.

Emerson Electric Manufacturing Co., St. Louis, Mo. Booklet No. 4440, devoted to small motors and their applications. Illustrated, 3½x6 inches, 12 pages, paper.

The Casino Technical Night School, Turtle Creek, Penn. Catalog containing calendar for 1906 and 1907, with courses of study, etc. Illustrated, 5½x7 inches, 50 pages, paper.

Norton Co., Worcester, Mass. Catalog of universal tool and cutter grinders. Half-tones and line drawings illustrating different operations are shown. 6x9 inches, 59 pages, paper.

Sprague Electric Co., 527-531 West 34th St., New York. Bulletin No. 219 (second edition), illustrating and describing round-type direct-current motors. 8x10½ inches, 23 pages.

Joseph Dixon Crucible Co., Jersey City, N. J. Booklet, "Air Brake Lubrication," describing Dixon's Ticonderoga graphite air brake and triple valve grease and Dixon's special graphite No. 635. 3½x6 inches, 13 pages, paper.

Whiting Foundry Equipment Co., Harvey, Ill. Catalog No. 47, describing various styles of ladles. Illustrated, 6x9 inches, 16 pages, paper. Catalog No. 48, describing direct-current solenoid brakes. Illustrated, 6x9 inches, 8 pages, paper.

Coates Clipper Manufacturing Co., Worcester, Mass. Bulletin No. 20, "Flexible Transmission," showing Coates flexible shaft adapted for various purposes, such as drive for drill, grinder, etc. Illustrated, 6x8 inches, 28 pages, paper.

Stanley-G. I. Electric Manufacturing Co., Pittsfield, Mass. Bulletin No. 615, illustrating and describing G. I. flush receptacle and attaching plug. 6x9 inches, 4 pages. Circular No. 798, illustrating and describing alternating-current motors for driving laundry machinery.

Miscellaneous Wants

Advertisements will be inserted under this head at 25 cents a line each insertion. Copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded.

Caliper cat. free. E. G. Smith, Columbia, Pa.

Cox Computers, 75 Broad St., New York.

Will buy or pay royalty for good patented machine or tool. Box 282, AMER. MACHINIST.

Light, fine machry. to order; models and elec. work specialty. E. O. Chase, Newark, N. J.

Dies and Diemaking, $1.00. A shop book by a shop man. J. L. Lucas, Bridgeport, Ct.

Novelty in tool or machine specialty wanted. Particulars required. Box 202, AMER. MACH.

Special machinery designed and built. Walter S. McKinney, M. E., 43 Broadway, Flushing, N. Y.

Gas engines designed to order. Marine and automobile work a specialty. H. L. Towle, 150 Nassau street, New York.

Special machinery accurately built. Screw machine and turret-lathe work solicited. Robt. J. Emory & Co., Newark, N. J.

Wanted — Brown & Sharpe 00 automatic screw machine, 1905 or 1906; state condition and price. J. S., Box 255, AMER. MACHINIST.

Universal grinding machine, about 12x32, new or second-hand, first-class condition, wanted; immediate delivery. Box 237, AM. M.

Wanted—New or second-hand lathes in good condition; 30″ to 36″ swing; short beds; quote prices and name of makers. Wildman Mfg. Co., Norristown, Pa.

Machinery and machine-tool manufacturers. The advertiser has a large office in New York City; am open for proposition to represent some manufacturer. Box 234, AMER. MACH.

A large English firm of machine-tool importers, having showrooms and offices in France, Italy and Japan, is wanting good agencies for machine tools of all kinds. Apply Box 189, AMERICAN MACHINIST.

The J. Geo. Leyner Eng. Wks. Co., of Littleton, Colo., are increasing their plant and are in need of good mechanics, machinists, blacksmiths and sheet-iron workers. Littleton is a suburb of Denver, where cost of living is reasonable; superb climate the year round. Address above.

Draftsmen, engineers, graduates—Join the Automobile Designing School and earn $30 to $60 a week. Positions waiting for you. Day and evening classes and by mail. New classes now starting. Write for prospectus. The Automobile Designing School, 1416 Broadway, New York City.

Tool catalog No. 22, 950 pages bound in cloth. Greatest small-tool catalog ever published. Will be sent post-paid on receipt of $1. Money paid for catalog refunded with first purchase amounting to $10 or over. Book costs you nothing if you become a customer. Montgomery & Co., 109 Fulton street, New York City.

We can build machinery for quick delivery. Having complete tool equipment, we wish to add to our present capacity for continuous output. Steam or gas engines preferred, or anything to be produced in a modern and up-to-date foundry and machine shop. Send drawings and specifications and we will give you estimate. United States Engine Co., Parkersburg, W. Va.

Be a draftsman making $150 monthly by taking individual instructions from chief draftsman of large concern, who will in a few months' home study equip you fully with complete drafting-room knowledge and practical experience to start you at $20 or $30 weekly salary and rapidly advancing. Furnish all tools free of charge, and a steady position when competent. Reasonable terms and success guaranteed. Write at once. Chief Draftsman, Division 4, Engineers Equipment Company, Inc., Chicago.

Mr. R. E. Mathot, Memb. Am. S. M. E., an expert in gas engines and well known author of several works and lectures on the matter of gas engines and producers, as well as on automobiles, writer of the work, "Gas Engines and Producer-Gas Plants," edited by N. Henley, of New York, will make his annual trip in America next November. Those interested in his specialties who would like to meet him for a talk or consultation regarding improvements in their construction or plants, might write him for an appointment. Letters to be addressed care this paper or care Am. Soc. Mechanical Engineers, 12 West 31st street, New York.

Business Opportunities

Shipsmiths, engineering, contracting business—Want good active partner; either on business end or technical end. Must buy an interest. Box 247, AMERICAN MACHINIST.

Negotiations desired with a machinery builder having facilities to manufacture tools from 1000 to 6000 lbs., and wishing to extend his business with an established and profitable line. An Eastern manufacturer preferred. Box 248, AMERICAN MACHINIST.

Wanted to contract with shop within 50 miles of New York City, equipped for making highest-grade automobile chassis. Must have capacity for at least 100 cars per year and able to do highest grade interchangeable work cheaply. No body work. Box 210, AM. MACH.

We can build machinery for quick delivery. A shop building machine tools wishes to take contracts for the construction of machinery or anything that can be produced in a foundry and machine shop. Send drawings and specifications and estimates will be made with guarantee of quick delivery. We can refer to a standard line of tools now on the market as to the quality of workmanship. Box 75, AMERICAN MACHINIST.

For Sale

For Sale—Foundry, wood and iron machine shop. Box 74, Albion, N. Y.

For Sale—A modern equipped machine shop doing a general jobbing trade, with a good line of customers, in one of the best manufacturing towns of Indiana of 20,000 inhabitants; building can be leased on reasonable terms; good reasons for selling. Address Standard Motor Co., Kokomo, Ind.

For Sale—Established manufacturing plant in one of the largest and best middle West cities, consisting of machine, blacksmith and pattern shops, well equipped for every class of work and now engaged on a large amount of profitable contract, repair and special work; good reason for selling; cheap for cash, or terms to suit purchaser. Address Box 249, AMERICAN MACHINIST.

Wants

Situations and help advertisements only inserted under this head. Rate 25 cents a line for each insertion. About six words make a line. No advertisements under two lines accepted, and no advertisements abbreviated. The cash and copy should be sent to reach us not later than Friday for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded, they will be destroyed without notice. Original letters of recommendation or other papers of value should not be enclosed to unknown correspondents. Only bona fide situation want or help want advertisements inserted under this heading. Agency advertisements must be placed under Miscellaneous Wants.

Situations Wanted

Classification indicates present address of advertiser, nothing else.

CANADA

Position wanted by man aged 35; has had 18 years' experience in machine shop, nine years of which time was on gasolene engines; have owned and operated shop and handled men for the past 13 years. Box 158, AM. M.

ILLINOIS

Assistant general manager, technical graduate, desires position with engine or machinery manufacturing plant. Box 243, AM. M.

Superintendent or assistant; young man, technical education, practical experience, thorough mechanic, familiar with modern methods, tools, jigs, fixtures and high-speed steels, in the rapid, accurate production of small and medium-sized duplicate interchangeable parts; references; any location. Box 244, AM. M.

MASSACHUSETTS

Technical man, tool and machine designer of eight years' experience, would change. Box 224, AMERICAN MACHINIST.

Superintendent or assistant—Practical 12 years' experienced toolmaker; 32; modern practice; systematizer, designer tools, jigs, fixtures, high-speed steels; now foreman of toolroom and several other departments; references; salary start $1800. Box 241, AM. M.

NEW JERSEY

Experienced mechanical draftsman desires position. Box 228, AMERICAN MACHINIST.

NEW YORK

Wanted—Position as superintendent or general foreman by experienced party; specialty, automobiles and machinery. Box 256, AM. M.

Inventor, with 10 years' experience in steam engines, automatic machinery, die work and steam turbines, is open for a first-class engagement. Box 252, AMERICAN MACHINIST.

General foreman—organizer and systematizer, varied experience in economically manufacturing high-grade, interchangeable and special machinery, master machinist—desires change; age 36; salary $1500. Box 242, AMERICAN MACHINIST.

Young man (35) wants a position where opportunity is given for advancement; has been employed by the T. R. Almond Mfg. Co., Brooklyn, a number of years as toolmaker and foreman. Address V. Wickman, 322 Fifty-fifth street, Brooklyn, N. Y.

Experienced and successful designer of special machine tools and fixtures is open for engagement; accustomed to best manufacturing methods; would be glad to hear from those only who expect to pay a good salary for good work. Address Box 240, AM. MACH.

Representative and salesman wishes change; would consider position with well established concern desiring competent and result-producing man; New York and vicinity preferred; 10 years' shop and drawing-room experience, four years' commercial, office and selling experience; technical graduate; standard, modern and special, heavy and medium machine tools and general machinery; excellent references; large acquaintance. Box 235, AM. M.

OHIO

Superintendent, technical education, desires change; 20 years' experience engine, pump and general machine; wishes to locate with parties to build engines, triplex pumps or automobiles. Box 214, AMERICAN MACHINIST.

PENNSYLVANIA

Position wanted—Young mechanical engineer desires a change; technical graduate; three years' shop experience and 2½ years drafting on machine design and general engineering. Box 254, AMERICAN MACHINIST.

WISCONSIN

Assistant to superintendent or works manager by man 28; college education, ability and wide experience; one year in shop, four years in drafting rooms; now first designer for pumping engines. Box 236, AMER. MACH.

WEST OF MISSISSIPPI

Situation wanted—Have had nine years' experience as draftsman, chief draftsman and tool designer on rifles, adding machines and automobiles; hold good position, but wish to return East; excellent references. Box 253, AMERICAN MACHINIST.

Help Wanted

Classification indicates present address of advertiser, nothing else.

CALIFORNIA

Foreman for old established western gas-engine plant manufacturing stationary, marine and hoisting engines; must be a good organizer, able to handle men, up-to-date and able to show results; a man of experience, with good references; the right man can secure a permanent position with chance to advance soon; give full particulars. Box 121, AMERICAN MACHINIST.

CANADA

Wanted — Toolmakers experienced on fixtures, dies and gages. Applicants should give age, experience and wages expected. Ross Rifle Co., Quebec, Canada.

CONNECTICUT.

Wanted—First-class operator on Jones & Lamson turret lathe; also one first-class all-around machinist. The New Machine Co., Danbury, Conn.

Wanted — Tool makers, die sinkers, drop forgers and men familiar with grinding machines. Apply to D. P. Beckwith, Pope Manufacturing Company, Hartford, Conn.

ILLINOIS

Wanted—By large wagon factory, experienced mechanical draftsman for work on traction trucks and heavy wagons. Box 238, AMERICAN MACHINIST.

Wanted—Steady and reliable machinist for jobbing shop in Chicago; must be familiar with engine and pump repairing inside and outside of shop; steady employment for right man; open shop; state experience, age and wages expected. Box 246, AMER. MACHINIST.

Mechanical draftsman wanted—A man with wide experience, thoroughly familiar with machinery drafting, and who has executive ability to take position as assistant of a large mechanical drafting department; prefer a man of college education; in answering, state age, experience and such other information as would be helpful in passing upon your application. Address all replies to Box 183, AMERICAN MACHINIST.

INDIANA

Wanted—First-class toolmakers and lathe men; increasing business, manufacturing automobile motors. Address Western Motor Co., Logansport, Ind.

MASSACHUSETTS

Inspector of jobbing work, gear specialist preferred; also one assistant shop manager. Gears, Box 215, AMERICAN MACHINIST.

Wanted—First-class outside erecting men familiar with steam engines. Location near Boston. Box 212, AMERICAN MACHINIST.

Wanted—Draftsmen and tracers on printing-press work; state age, experience and salary required. Address Box 197, AM. MACH.

Wanted — First-class machinists on automobile work. Apply to manager, Waltham Mfg. Co., makers of Orient automobiles, Waltham, Mass.

Mechanical draftsmen wanted for general machine work, also structural steel work; state age, experience and salary expected. Box 251, AMERICAN MACHINIST.

Wanted — First-class toolmakers, milling machine, floor and vise hands on high-grade medium weight machinery; good pay and permanent positions to competent workmen. Box 85, AMERICAN MACHINIST.

Wanted—An experienced operator on Gould & Eberhardt gear cutters on heavy work; a man who knows how, and can tell how, to cut

gears; man with theoretical and practical knowledge preferred. Box 233, AMER. MACH.

Tool dresser—Expert hand forger and tool dresser, familiar with the tempering of milling, profiling and counter-boring cutters; must have experience on Novo steel and high-carbon steel; $24 per week; permanent employment. Write Y. M. C. A., Employment Department, Springfield, Mass.

Wanted — Experienced mechanical draftsman for permanent position. Apply to Engineer in charge Drawing Office, General Electric Co., West Lynn, Mass., giving full particulars regarding age, education, experience and smallest salary acceptable for first year. Box 250, AMERICAN MACHINIST.

NEW JERSEY

Wanted — Experienced foreman patternmaker, with foundry experience preferred; open shop. Address Box 231, AMER. MACH.

Wanted—Working foreman for small shop doing jobbing, mold work and building special machinery; give references and salary expected. Address "M," Box 201, AMER. MACH.

Wanted—First-class outside man with experience in running small-sized steam engines, gasolene engines and electric motors, and attending to complaints on same. Address Box 686, Plainfield, N. J.

Wanted—Six first-class mechanics who have had experience on fine small work of interchangeable character; permanent positions and good wages. Address, giving age, experience and reference, Box 232, AMER. MACH.

Several first-class tool and diemakers accustomed to high-grade work; steady employment and good wages to competent men. Sloan & Chace Mfg. Co., Sixth avenue and Thirteenth street, Newark, N. J.

We are increasing our tool-making department and solicit applications from toolmakers and machinists who are experienced on fine and complicated work. Apply to Victor Talking Machine Co., Camden, N. J.

We have increased our plant and desire floor and vise hands for day work and lathe hands for night work. Good pay and steady work to good men. Address or apply at Pond Machine Tool Co., Plainfield, N. J.

Factory superintendent, thoroughly capable of taking entire charge of manufacturing arc lamps and small electric apparatus; thorough mechanical training and ability to handle men required; must be familiar with cost and piece-work system; state reference and salary. Box 229, AMERICAN MACHINIST.

NEW YORK

Wanted—Experienced men on general tool work; steady positions for the right men. Remington Typewriter Factory, Ilion, N. Y.

Wanted — Experienced draftsmen, toolmakers and machinists. Give age, references and wages expected. Remington Arms Co., Ilion, N. Y.

Wanted, immediately, machinists; must be good lathe hands; applicants must give wages expected. Address "P. C. W.," Alsen, Greene Co., N. Y.

Wanted — Metal patternmaker and wood patternmaker on agricultural implement work; position permanent. Adriance, Platt & Co., Poughkeepsie, N. Y.

Screw machine hands wanted on Brown & Sharpe automatics; highest wages and steady employment to first-class men. Apply at 37 West 116th street, New York City.

Wanted—Mechanical and electrical draftsmen. Apply, giving age, experience and salary expected, Engineer in Charge, Drafting Department, General Electric Co., Schenectady, N. Y.

Wanted, foreman — A brass manufacturing firm wants a first-class experienced foreman familiar with line of steam appliances. Address "Manufacturing Foreman," Box 239, AMERICAN MACHINIST.

Wanted—Chief draftsman, accurate, with executive ability and extensive experience in Webb printing-press designing; to a competent man we can offer a permanent position at a good salary. Apply Box 182, AM. MACH.

OHIO

Draftsman wanted—State wages and experience. Box 230, AMERICAN MACHINIST.

Machine-tool draftsmen wanted for Ohio; detailers or designers. Box 245, AM. MACH.

Wanted—Designers and detailers on heavy machine tool work; state age and experience. Box 218, AMERICAN MACHINIST.

Our growing business constantly requires additional machinists. We build lathes, planers, shapers, drilling machines; good opportunity for machinists. The American Tool Works Co., Cincinnati.

The National Metal Trades Association can place a few first-class toolmakers, patternmakers and blacksmiths. Positions will be guaranteed as steady and at highest prevailing rate of wages. This is an opportunity for first-class men to secure one of the N. M. T. A. certificates of recommendation. For further particulars address The National Metal Trades Association, Cincinnati, O.

Wanted — Superintendent of a large and growing factory, employing now about five hundred (500) hands, manufacturing high-class electrical product, wishes an assistant thoroughly up-to-date on quick interchangeable work at lowest cost; a man to become master mechanic in time; this is an excellent opportunity. Reply, giving age, whether married or single, past experience in detail. All letters acknowledged and held confidential. Box 205, AMERICAN MACHINIST.

PENNSYLVANIA

Wanted—Ten machinists, lathe, planer, boring mill and bench hands; steady work. Apply to Scottdale Foundry & Machine Co., Scottdale, Pa.

Draftsmen—A large firm of engine builders in western Pennsylvania wants draftsmen and tracers. State age, education, experience, and salary expected. J. A. M., Box 45, Pittsburg, Penn.

Wanted—Foreman for boiler shop employing 75 to 125 men; one who can handle men to advantage and get out first-class work at a minimum cost; shop located in western Pennsylvania. Box 161, AMER. MACHINIST.

The Monotype Company maintains a free school for training young machinists to operate its type casting and composing machines. The demand for monotype operators is so great that it receives more applications for places in its school than can be filled. In making selections, these qualifications carry most weight: Character, common sense, experience with automatic machinery (or) printing-office experience, or type-foundry experience. Full particulars will be furnished to inquirers who furnish full particulars about themselves. Lanston Monotype Machine Co., 1231 Callowhill St., Philadelphia, Pa.

RHODE ISLAND

Wanted—A few mechanical draftsmen, men with shop experience preferred. State age, experience and salary expected. Box 225, AMERICAN MACHINIST.

Toolmakers wanted — First-class workmen on jig and fixture work for light high-grade machinery. Permanent employment to competent workmen. Apply to the Taft-Peirce Mfg. Co., Woonsocket, R. I.

WISCONSIN

To cope with the continuous enlargement of our business, first-class machinists, patternmakers, molders and boilermakers can find steady employment. Box 899, Milwaukee, Wis.

Foundry superintendent is wanted for manufacturing company in middle West, melting 100 tons iron a day; a live up-to-date man is wanted, with experience on both large and small work; open shop; molding machines extensively used; beautiful small city. Address Box 153, AMERICAN MACHINIST.

Large concern building excavating and railway machinery wants to correspond with first-class mechanical draftsmen with view to filling future vacancies as they occur; wants men now employed; give full experience and reason for changing; shop experience great advantage; all letters acknowledged and held confidential. Box 919, AMERICAN MACHINIST.

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